DOCUMENT RESUME

ED 060 154 | 24 | UD 012 218

AUTHOR	Young, Beverly S.
TITLE	Inducing Conservation of Number, Weight, Volume, Area and Mass in Disadvantaged Pre-School Children: A Mathematics Readiness. Final Report.
INSTITUTION	Stephen F. Austin State Univ., Nacogdoches, Tex.
SPONS AGENCY	Office of Education (DHEW), Washington, D.C. Bureau of Research.
BUREAU NO	BR-0-G-043
PUB DATE	Dec 70
GRANT	OEG-7-70-0160(509)
NOTE	101p.
EDRS PRICE	MF-$0.65 HC-$6.58
DESCRIPTORS	*Cognitive Development; College Students; Concept Formation; *Conservation (Concept); *Disadvantaged Youth; Educational Diagnosis; Intervention; *Mathematics; Negro Students; Preschool Education; Preschool Learning; *Preschool Programs; Preschool Teachers; Program Evaluation; Readiness

ABSTRACT

The purpose of the study was to determine whether mathematical concepts could be learned and retained by disadvantaged preschool children when taught by an inexperienced teacher. College sophomores used printed lesson plans with no further instruction with 94 severely disadvantaged children attending either Headstart schools of Day Care Centers in the deep south. The lessons consisted of two 10-minute lessons on the concepts "more" and "same" and eight 10-minute conservation lessons. Following the teaching sessions the experimental groups, each composed of four to six children, and control groups were each randomly split. Half were post-tested immediately. The other half were post-tested six weeks later to check on retention. The main results were: experimental lessons were effective among disadvantaged children; lessons were simple enough to be taught effectively by inexperienced teachers; and there was a significant difference in effectiveness of the lessons at different chronological, mental age, and IQ levels. (Author/LM)

ED 060154

Final Report

Project No. OG043
Grant or Contract No. OEG - 7 - 70 - 0160 - (509)

Title of Report

INDUCING CONSERVATION OF NUMBER, WEIGHT, VOLUME, AREA AND MASS IN DISADVANTAGED PRE-SCHOOL CHILDREN: A MATHEMATICS READINESS

Beverly S. Young

Stephen F. Austin State University

Nacogdoches, Texas

December 1970

The research reported herein was performed pursuant to a grant with the Office of Education, U.S. Department of Health, Education, and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Office of Education position or policy.

UD012218

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

Office of Education
Bureau of Research

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION
THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL OFFICE OF EDUCATION POSITION OR POLICY

CONTENTS

	page
SUMMARY	1
INTRODUCTION	1
CHAPTER I--METHOD	1
Subjects	1
Pilot Study	1
Tests	2
Lessons	4
Analysis	6
CHAPTER II--FINDINGS AND ANALYSES	7
Analysis I	7
Analysis II	7
Analysis III	21
Analysis IV	29
Analysis V	34
Analysis VI	34
Analysis VII	39
Analysis VIII	39
Analysis IX	39
Analysis X	39
Analysis XI	45
CHAPTER III--CONCLUSIONS AND RECOMMENDATIONS	51
Conclusions	51
Recommendations	53
BIBLIOGRAPHY	54
APPENDICES	57
APPENDIX A	59
TEST FOR ROTE COUNTING	61
TEST FOR RATIONAL COUNTING	61

TEST FOR DISCRIMINATION OF NUMBER---------- 62
TEST FOR CONSERVATION OF CARDINAL NUMBER---------- 63
TEST FOR ADDITIVE COMPOSITION OF NUMBER---------- 65
TEST FOR DISCRIMINATION OF LENGTH---------- 67
TEST FOR SERIATION---------- 68
TEST FOR CONSERVATION OF ORDINAL NUMBER---------- 69
TEST FOR MULTIPLICATIVE COMPOSITION OF NUMBER---------- 70
TEST FOR TRANSITIVITY---------- 72
TEST FOR CONSERVATION OF WEIGHT---------- 74
TEST FOR CONSERVATION OF MASS---------- 75
TEST FOR CONSERVATION OF VOLUME---------- 76
TEST FOR CONSERVATION OF AREA---------- 78
TEST FOR REVERSIBILITY---------- 79

APPENDIX B---------- 81

LESSON 1---------- 83
LESSON 2---------- 85
LESSON 3---------- 87
LESSON 4---------- 89
LESSON 5---------- 90
LESSON 6---------- 92
LESSON 7---------- 94
LESSON 8---------- 95

TABLES

page

Table I--MEANS AND INTERACTION BETWEEN EXPERIMENTAL AND CONTROL GROUPS ON PRE- AND POST-TEST---------- 9

Table II--PRE-TEST AND POST-TEST MEANS IN TOTAL CONSERVATION OF NUMBER, WEIGHT, VOLUME AND AREA FOR EXPERIMENTAL AND CONTROL GROUPS---------- 10

Table III--DIFFERENCE IN GAIN BETWEEN EXPERIMENTAL AND CONTROL GROUPS ANALYZED BY MA LEVELS---------- 15

Table IV--MEAN GAIN IN CONSERVATION OF DISCRIMINATION OF NUMBER, PROVOKED CORRESPONDENCE, UNPROVOKED CORRESPONDENCE, AND TOTAL CARDINAL NUMBER ANALYZED BY MA LEVELS---------- 16

Table V--DIFFERENCES IN GAINS BETWEEN EXPERINENTAL AND CONTROL GROUPS IN COMBINED PRESCHOOL STUDIES WHEN ANALYZED BY MA---------- 22

Table VI--DIFFERENCE IN GAIN BETWEEN EXPERIMENTAL AND CONTROL GROUPS IN COMBINED STUDIES WHEN ANALYZED BY MA LEVELS- 24

Table VII--DIFFERENCES IN GAIN BETWEEN ADVANTAGED AND DISADVANTAGED PRE-SCHOOL GROUPS WHEN ANALYZED BY MA LEVELS---------- 30

Table VIII--DIFFERENCE IN GAIN BETWEEN DISADVANTAGED, EXPERIMENTAL AND CONTROL GROUPS ANALYZED BY IQ LEVELS---------- 32

Table IX--DIFFERENCE IN GAIN IN CONSERVATION BY DISADVANTAGED CHILD WHEN ANALYZED BY IQ LEVELS---------- 35

Table X--DIFFERENCE IN GAIN BETWEEN EXPERIMENTAL AND CONTROL GROUPS IN COMBINED STUDIES ANALYZED BY IQ LEVELS------ 36

Table XI--DIFFERENCES IN GAIN IN CONSERVATION IN COMBINED STUDIES WHEN ANALYZED BY IQ LEVEL---------- 38

Table XII--DIFFERENCES IN GAINS BETWEEN ADVANTAGED AND DISADVANTAGED PRESCHOOL GROUPS WHEN ANALYZED BY IQ LEVELS---------- 40

Table XIII--MEAN CA, MA, AND IQ OF ADVANTAGED AND DISADVANTAGED PRESCHOOL GROUPS WHEN ANALYZED BY IQ LEVELS---------- 42

Table XIV--DIFFERENCE IN GAIN IN CONSERVATION BETWEEN SOCIAL CLASSES WHEN ANALYZED BY IQ LEVELS---------- 43

Table XV--DIFFERENCE IN GAINS BETWEEN DISADVANTAGED EXPERIMENTAL AND CONTROL GROUPS ANALYZED BY CA LEVELS- 44

Table XVI--DIFFERENCE IN GAINS BETWEEN EXPERIMENTAL AND CONTROL GROUPS IN COMBINED PRESCHOOL STUDIES ANALYZED BY CA LEVELS---------- 46

Table XVII--DIFFERENCES IN GAINS BETWEEN ADVANTAGED AND DISADVANTAGED PRESCHOOL GROUPS WHEN ANALYZED BY CA LEVELS---------- 48

Table XVIII--MEAN CA, MA AND IQ OF ADVANTAGED AND DISADVANTAGED PRESCHOOL GROUPS WHEN ANALYZED BY CA LEVELS---------- 50

INDUCING CONSERVATION OF NUMBER, WEIGHT, VOLUME, AREA AND MASS IN DISADVANTAGED PRE-SCHOOL CHILDREN: A MATHEMATICS READINESS

SUMMARY

In 1967, Young completed a study in which conservation of number, weight, area, mass and volume was induced and retained in 3 and 4-year-old advantaged preschoolers. These subjects, mean IQ 123, were attending a university preschool in the Mid-West. Eight, 10-minute lessons were taught by an experienced teacher. The present study is a replication study. The present study utilizes inexperienced teachers, college sophomores, such as are frequently employed as teachers or aids in preschool programs. They used printed lesson plans with no further instruction. The subjects in the replication study were severely disadvantaged children attending Headstart schools or Day Care Centers in the Deep South. In the original study the subjects were all caucasian while in the second the subjects were predominantly negro though caucasian and oriental races were represented. The total N. completing the replication study was 94, mean IQ 86. When the studies were combined in an A x B x C Analysis of Variance, the combined N. was 226.

Problem.

The problems being investigated were:

1. Could these lessons effectively induce conservation of number, weight, area, mass and volume in severely disadvantaged children?

2. Could an inexperienced teacher with no guidance other than printed lesson plans effectively induce conservation in these severely deprived children?

3. Would the lessons be more effective at certain MA, CA, or IQ levels?

4. Would the concepts be retained or would they be subject to extinction?

5. When the advantaged and disadvantaged children were equated in terms of MA or IQ, would they learn in the same way and rate? Would the pattern of learning be the same?

Methods.

At pre-test all subjects were tested individually on the criterion test and the Stanford-Binet Intelligence Test. The criterion test was composed of two equivalent forms and a counter balanced design was used. The subjects were randomly placed in either experimental or control groups and the experimental group was then, sub-divided homogeneously

into teaching groups of 4-6 each on the basis of their composite pre-test scores. The lessons consisted of two, 10-minute lessons on the concepts "more" and "same" and eight, 10-minute conservation lessons. The necessity of adding the two language concept lessons was noted in the pilot study preceding the study proper. The disadvantaged child's language development was so meager, that the majority had no idea what was meant by two have the "same" or by someone having "more."

The lessons were taught in the Headstart or Day Care Centers on Monday, Wednesday, and Friday for three weeks. Following the teaching sessions the experimental and control groups were each randomly split. Half were post-tested immediately. The other half were post-tested 6 weeks later to check on retention.

Findings.

The findings of the study were as follows:

1. The experimental lessons in conservation of number, weight, volume, area, and mass were effective for improving these concepts among disadvantaged children.

2. The lessons were simple enough to be taught effectively by inexperienced teachers using only printed lesson plans with no additional assistance.

3. There was a significant difference in effectiveness of the lessons at different CA, MA, and IQ levels.

4. There was a significant difference in the level at which the lessons should be placed in the two social classes.

5. The lessons were effective with the advantaged children at all CA, and IQ levels included in this study. (CA 3-6 years, IQ levels 60-167) and in all MA levels above 3 years (MA 3-9). It was not effective when the MA was below 3 years. There was, however, a marked improvement in gain in IQ levels above 65.

6. With the disadvantaged child, a different pattern appeared.

a. The experimental lessons were significantly superior in IQ levels 66-100, but were not as effective as the enriched environment in IQ levels below 65 and above 100.

b. The experimental lessons were significantly superior with the disadvantaged child with an MA of 4 years or older but were inferior to the enriched curriculum below this MA.

c. The experimental lessons were significantly superior with disadvantaged children with a CA of 5 years or older but were inferior to an enriched environment below CA 5.

7. Because the control method (enriched environment) showed very satisfactory gains in conservation below 3 years in contrast to the experimental method, one must reject the hypothesis that there is a biological limit (physical and/or neurological) at approximately the MA of 3 years, below which conservation could not be taught. One can only assume that the experimental method was not appropriate for use below the MA of 3 years.

8. The analysis for retention showed that the subjects post-tested six weeks following instruction showed significant (.05) greater gain in conservation than those post-tested immediately following instruction. No extinction had occurred, on the contrary the subjects had retained and added to their concept of conservation.

Findings revealed by the study about which no prior hypothesis had been made.

9. When the advantaged child and the disadvantaged child were matched in MA, the advantaged child still made significantly greater gains in this type of learning, which was basically logic. The advantaged child's initial pretest score was higher and his gain was greater than the disadvantaged child with the same MA.

10. When the advantaged child and the disadvantaged child were matched in IQ level, the advantaged child made significantly greater gains in learning.

11. When the advantaged child and the disadvantaged child were matched in CA, at the 5-year-level, the advantaged child averaged $2\frac{1}{4}$ years older in MA. (It may be noted that the data indicated that the lessons should be placed at the 3-year-old level with the advantaged child and the 5-year-old level with the disadvantaged child.

12. Since all levels showed gain in conservation concepts and because the rate of gain was significantly affected by difference in teaching methods, one may assume that conservation is a learning process and not primarily a biological maturational process for the MA levels $2\frac{1}{2}$ through 9, the limits included in this study.

It appeared that conservation did not suddenly occur at ages 7, 9, or 12 but was acquired gradually, bit by bit, from infancy (2 years or younger) through the years and reached maturity, or the stage of conservation, as soon as sufficient evidence had come to the attention of the subject, which might be at age 3 or 4 (Young, 1967) if the evidence were systematically brought to the attention of the child or at ages 7, 9, or 12, if this were left to chance.

13. Because of the pattern of interaction between the experimental method and control method it seemed that as soon as a language readiness was achieved at about CA 3 for advantaged children and a CA of 5 for this particular group of disadvantaged child, the structured play

(experimental method), was superior whenever the learning task was difficult in relation to the maturity of the child. However, when the task was easy by virtue of the child nearing the completion of the concept by incidental observation, the method was not a crucial matter and made no significant difference.

14. The experimental method was significantly superior for teaching rational counting to the disadvantaged children at the MA of 3-5. Since it was not primarily the purpose of the lessons to teach rational counting, it was assumed that the heavy emphasis on use of concrete objects coupled with occasional counting accounts for the effectiveness with this young age group.

Recommendations.

The results of the study indicate that these lessons in conservation could profitably be placed in the nursery school and kindergarten curriculum of children with an MA of 4 years or above or in the curriculum for 3-year-olds who are well advanced in language development.

With underprivileged children, the correct placement would be in kindergarten or early in the first grade.

Because the learning showed a gradual increase at every level, it would seem wisest to repeat the conservation lessons using new materials. It is the opinion of the researcher that this should be done approximately once a year. However, no evidence exists in the present study as to the optimum length of the cycle. This is only a subjective judgment on the part of the researcher after working with approximately 300 preschool children using the described lessons.

INTRODUCTION

Early efforts to induce conservation, exemplified by the investigations of Smedslund (1959-1962), Wohlwill (1959), and Mermelstein and Meyer (1968), employed a single variable. In general, this single variate approach met with little measurable success, regardless of the media employed. In contrast, those studies in which a multiple variate approach was used have produced more favorable results. Wallach and Sprott (1964), Bruner (1966), using number, volume, and mass, respectively, reported significant results in inducing conservation in these media by the use of multiple variables. Moreover, the study by Sonstroen (1966) made very clear the marked interaction between variables in the multivariate approach. All of these studies, in the main, employed subjects of Kindergarten age or older.

In a more recent study, by Young (1968), it was demonstrated that significant results could be obtained in inducing and retaining conservation of number, weight, volume, area, and mass with three and four year old children through the use of a multivariate approach. In this case, the subjects were all from advantaged home environments in the Midwestern United States. The results of this study indicated that there was no significant difference in gain in conservation between IQ levels which suggested that perhaps this same approach might be successfully employed in the instruction of children possessing less than average IQ.

The purpose of the present study was to determine whether conservation of number, weight, volume, area, and mass could be learned and retained by disadvantaged preschool children when taught by an inexperienced classroom teacher. The two major objectives of the study were incorporated in the following research hypotheses:

> (1) The course of lessons which was effective in inducing conservation of number, weight, volume, area, and mass with advantaged preschool children would also be effective with severely disadvantaged children of a comparable age.
>
> (2) The course of lessons which was effective when taught by an experienced teacher is simple and direct enough to be understood and taught effectively by an inexperienced teacher.

As an aid in the correct age placement of conservation lessons within the quantitative readiness curriculum, a third subordinate hypothesis was formulated and tested;

> (3) There is no difference in rate of gain between various levels of mental age, chronological age, or IQ.

On a more theoretical level two additional problems were investigated.

(4) The concepts so induced would be retained. Those subjects post-tested after a period of time would exhibit no measurable extinction.

(5) If advantaged children were equated with disadvantaged children in MA or IQ, there would be no significant difference in their rate or pattern of learning.

The findings would have important practical significance in the development of appropriate curriculum in quantitative concepts for preschool and kindergarten in disadvantaged areas.

Chapter I

METHODS

Subjects.

The study was initiated with 200 disadvantaged preschool children. These subjects constituted the entire Headstart population of Nacogdoches and Mount Enterprise, and all the children from three to five years of age in the Day Care Center at Lufkin, Texas. These cities were located in East Texas near the Louisiana border. East Texas may be characterized as a sub-tropical region. The rolling terrain is heavily forested with tall pine trees and is lush with other vegetation. Small unpainted cabins are scattered throughout the forests and clustered together in areas of the cities. Their inhabitants live in the most primitive of conditions. The subjects were predominantly negro, although caucasion and oriental races were also represented.

The children were located at five attendance centers. The subjects at each center were randomly placed in an experimental or a control group. Because of unstable home and school conditions, poor health and attendance and non-existance of records in several cases, complete data were available for only 97 of the 200 subjects. Of those who remained in the study until the end of the semester, the average daily attendance was 50%. The average IQ of the subjects completing the study was 86 and ranged from 51 to 117.

In addition to erratic attendance a severe language deficit was a major problem. Most did not have the words "more" or "same" in their vocabulary. Many did not know a fork or spoon by name or know their own given names, first or last.

Number instruction in the Headstart schools consisted largely of games and occasional practice in counting. Both experimental and control groups had these experiences in common.

Pilot Study.

The pilot study was conducted at one attendance unit composed of 40 children aged three through five. The original conservation curriculum which had been created and tested by the author with advantaged three and four-year-olds, consisted of eight, 10 minute lessons. During the first lesson of the pilot study with the disadvantaged children, it was obvious that they had no concept of "more" or "same" so the lessons were suspended and two additional lessons were devised, one to teach the concept and word "more," the second to teach the concept and word "same." Following these two lessons the remaining 7 conservation lessons were received with much greater comprehension than had been the initial lesson. The resulting ten lessons were then used for the balance of the study. The sequence

of administration of items in the criterion tests was revised slightly to cut administration time still further in recognition of the very short attention span of most of the children. Because of the high attrition rate and because the school changed locations and transportation was not available, only 18 of the original 40 children in the pilot study were able to remain in the study until the end of the semester.

Tests.

The criterion scores were based on two equivalent forms of a 57-item conservation test, one test of rote counting and one test of rational counting. The conservation test had 17 subtests of three to six items each. Each subdivision is graduated in difficulty and dealt with a different aspect of the concept of conservation. Total administration time for the battery was approximately 25 minutes. See Appendix A.

All test items were taken directly from the tasks used by Piaget to identify and describe his hypothesized stages of development in conservation. In most cases the tasks were identical with those of Piaget. In the original studies, Piaget emphasized that the materials used in his experiments were those familiar to the subjects. In cases where these materials were not common in the environment of this group of children, the materials of this study were modified so that they, too, were familiar in the life of these children. For instance, egg cups with two or three eggs each were changed to small transport trucks with two cars each in Form II to doll plates with three pieces of miniature silverware in Form I. In all cases the questions were the same as those reported by Piaget.

The Stanford-Binet Intelligence Test was used to determine intelligence level.

Procedures Used in Administration. Each subject was administered a Stanford-Binet Intelligence Test and a Criterion pre-test and post-test. These were all given within the nursery school by qualified personnel from the research team.

The two forms of the criterion test were used in a counter-balanced design. The pre-testing extended over a five-day period, followed by approximately a $3\frac{1}{2}$ week teaching period. Lessons were taught Monday, Wednesday, and Friday until all ten lessons had been given.

At post-test both experimental and control groups were randomly placed in either an early post-test group or a late post-test group. Early post-testing began the day following the final conservation lesson and extended over a three-day period. Testing was then suspended for 5 weeks, after which time the late post-testing began with the groups designated as late post-testers and lasted for 3 days. By comparing the difference in retention, the type of learning could be better understood, whether or not it was subject to extinction and to what extent.

The subjects were tested in alphabetical order to the extent that this was possible. Illnesses and other nursery school activities made the order quite erratic. Because of these same factors, it was not possible to test in identical order for pre-test and post-test or in perfectly random order.

When administering the criterion tests, the subjects' reactions were carefully observed and when it appeared that a child did not understand the question, the vocabulary was altered until the child seemed to understand what was being asked. For instance, if "largest" and "smallest" were not in the child's vocabulary, "biggest" and "littlest" were substituted, or in a few cases, the "big Daddy one" and the "tiny baby one." It was felt that it was the concept of conservation which was to be measured and not the size of the subject's quantitative vocabulary. Within each subdivision of the conservation test, at least three questions were administered. If these three were all failed, the more difficult items were not administered. If, however, any of the first three were passed, all items of the subtests were administered.

In order to insure cooperation, the examiner gave each subject a piece of candy at the close of each session. This procedure was sufficient to maintain cooperation during the testing sessions. The treat was in no way dependent on how well the subject had done and each child was assured that he had done well.

Scoring. The criterion test was scored on the basis of one point for each correct answer. The scoring on the rote and rational counting was an adaptation of this policy.

In the rote counting subject, the score recorded was the number just preceding the one on which the subject faltered in the serial naming of the numbers. The subject was stopped at 20 if he counted that far without error. Twenty was then recorded. In the rational counting test, the subject received a score equal to the highest number of articles he placed correctly as directed. The task was discontinued at any point where an error was made which wasn't corrected when the examiner asked if the subject wished to check to be sure he had the right number. With the more mature subjects the task was initiated with the most difficult item and if passed, passes were credited for the easier items.

In the tests dealing with conservation, counting was not allowed because of its effect in masking the concept of conservation. The children who showed any inclination to count were asked not to do so. If counting took place in spite of these procedures, the child was scored a miss or 0 on that question. If was felt that this practice was justified by the fact that if the child had had a stable concept of conservation, he would have felt no need to count.

If is common knowledge that children are extremely suggestable and in case of doubt, attempt to answer as they believe the questioner would have them reply. This problem has been handled in various ways. One researcher presented all three alternatives. Another alternated alterna-

tives, making this one of his variables. In this case, it was not desirable to add another variable and presenting three alternatives often confused the younger child. The wording was therefore changed so as to include the three alternatives. By saying, "Are they the same or is one more than the other," it appeared to be only two alternatives--the same or more--and this was more easily grasped than was the wording, "Are they the same or is there more here or more there."

Any bias in the wording used would have been in the direction of non-conservation. In order to offset this bias, the examiner watched the subject carefully for any hint of indecision. In case there was the slightest doubt as to the child's certainty, the question was reversed and stated, "Is one more or are they the same?" If the child changed his answer following the reversal of the question which occurred occasionally, the examiner pointed out that the subject had said that they were both the same and also more and that he should think about it carefully and tell the examiner which he really meant. Following the responses, the question was again reversed. If the subject was consistent at this time in his reply, he was credited with whatever opinion he held. If, however, he was still inconsistent, he was scored a miss regardless of the correctness or incorrectness of the final answer.

In seriation the subject was asked to make a stairway with 10 blocks. He was given 1 point for each of the five test items which were 3, 5, 7, 10, and 14, correct placements, respectively. The last item of 14, required correctly interpolating 4 additional blocks whose increment was half as much as the first group.

There was no time limits on any subtest.

Sequence of Administration of Items. To maintain maximum interest on the part of the subjects, administration time was reduced as much as possible. Instead of administering all of subtest as a unit, the items from the various subjects were intermingled to reduce the handling of materials to the absolute minimum. During the pilot study the sequence of administration was further refined. For Criterion Test see Appendix A.

Lessons.

Administration. Since the use of single variables to induce conservation had proven unsuccessful and since the studies which had been successful in inducing conservation had used more than one variable and had showed significant interaction between the variables, it was decided to use multiple variables in the attempt to induce conservation in these children of preschool age. The variables used were:

a. Reversibility
b. Perceptual screening and mental imagery
c. Physical manipulation by subject and by examiner
d. Addition/substraction; subtraction/addition
e. Compensatory operation
f. Verbal Rule

4

g. Reinforcement
h. Cognitive conflict or equilibration
i. Identity
j. Labeling
k. Verbal instruction

The lessons (See Appendix B) consisted of ten, 10 minute sessions held three days a week, Monday, Wednesday and Friday over a 3-week period. The sessions were taught in groups of 3-6 children each within the nursery school or kindergarten. The teaching groups were formed on the basis of similarity in pre-test composite Criterion Test score. Due to absences and late arrivals sometimes experimental groups were combined or membership changed from one experimental group to another. This practice, though unavoidable under the circumstances, was not conducive to the best learning situation. It was found that it was quite important for the group to be very similar in initial achievement. Though exactly the same lessons was given to each group, the difficulty in combining groups arose from the fact that the more advanced children would quickly volunteer the answers while the slower ones were content to let them and never become personally involved themselves.

While this problem is rather easily controlled with more advanced children, it is most difficult to handle with children who have little or no concept of taking turns, respect for others rights, or motivation to achieve.

Conditions and facilities in the teaching situations ranged from adequate to unsatisfactory. However, the conditions were typical of those in which the Headstart or Day-Care Center teacher must operate and therefore were considered ideal for the field testing of these lessons. Problems most often encountered were incessant noise, continual interruptions, lack of heat, light, or tables and chairs, and overwrought, emotionally upset, and physically ill children.

These statements should not be interpreted as a reflection on any of the cooperating schools for in every case, they gave the research team access to the best facilities they had.

Absences due to illness and other causes were a much greater problem with the disadvantaged child than with the average preschooler. The only method of dealing with absences was to plan a 2-3 minute review at the beginning of the 10-minute period to provide continuity. However, since some of the children included in the experimental group only attended 3 or 4 of the 10 lessons, this practice was not sufficient.

There was no problem of motivation. The children expressed great interest and eagerness for each new session. However, interest span was very short and skill on the part of the teacher in handling materials and in keeping the lesson moving was absolutely essential for completing the lesson before interest wavered. In fact, interest was so high that one of the five control groups had to be dropped because they continuously invaded the teaching sessions in such large numbers that they observed so

much teaching that they could no longer be considered a legitimate control group. For examples of the conservation lessons used, see Appendix B.

Analysis.

A Type I Analysis of Variance Design (Lindquist, 1956) was employed to determine interaction. Whether or not the interaction was significant, it was predetermined to test the simple effects of this analysis to observe whether either the control or experimental groups had made any significant gain in conservation during the three week period. Three by-levels analysis were made using in the first case, CA levels, in the second case, MA levels, and lastly, IQ levels. F tests were used as tests of significance of interaction, t tests for the simple effects.

Following these analyses, the data from the study was combined with the earlier study of advantaged preschoolers of which it was a replication study, and six more analyses were made. Three used a Type II Analysis of Variance Design (Lindquist, 1956) for CA levels, MA levels, and IQ levels. And lastly, three more Type I Analyses of Variance with CA levels, MA levels, and IQ levels. Because of the extreme bimodality of the groups when combined, (IQ means 86 and 122, respectively), there resulted in a drastic loss of subjects in meeting the proportionality requirements in the Type II Analyses. Therefore, the less appropriate Type I Analyses were also used to gain the power of the full number of subjects, realizing that if significance were found it would be confounded by teacher and social class and would necessitate another replication of the study before findings from the last three analyses could be stated definitely.

CHAPTER II

FINDINGS AND ANALYSES

Analysis I.

The first analysis was a Type I Design (Lindquist, 1956) using the pre- and post-test criterion test means as A effect, experimental and control groups as B effects. Each of the tests and 17 subtests were analyzed individually. Although the gains made by the experimental groups (simple effect) exceeded that made by the control group in 16 of the 19 areas tested, the interaction reached significance (.05) in only one subtest, transitivity, one of the more difficult subtests. This seemed to be chiefly due to a chance difference in experimental and control group in pre-test means.

The A effects, composite experimental and control groups post-test means over pre-test means were significant in 17 of the 19 areas. (See Table I.)

The interaction of the two methods with MA levels, which is analyzed in detail later, was the chief cause for lack of more significant difference in this original analysis. This interaction caused the differences in the two methods to average out. Other major causes for the apparent similarity were irregular attendance at experimental teaching sessions, some subjects having attended only 3 or 4 of the ten sessions, and the slow learning rate all of which made differences small. Of course, another major factor was the really excellent results being obtained by the existing Headstart program, a finding which is contrary to most laboratory experiments and many reports of Headstart programs over the country.

Analysis I showed both methods to be good and were both making significant improvement in conservation concepts among disadvantaged preschool children.

Analysis II.

The second analysis consisted of an AxB, by-levels analysis, using gain scores. During the original study, (Young, 1967), it seemed that there was a lower physical limit below which conservation could not be taught. Among advantaged children this appeared among the 2-year-olds or among the retarded 3- or 4-year-olds. However, there had been too few subjects to make any sort of definite statement. A by-levels analysis above this level showed no significant difference in levels as to rate of gain. In the present study, it appeared that there might be sufficient number at the lower MA levels to get a significant finding. Subjects were randomly cast out to achieve proportionality.

In this analysis, the differences noted in the original research made a definite pattern. Below an MA of 36 months the experimental method was not effective. Between 36 and 60 months, the experimental method was as good or better than the control method, however, differences were small and inconsistent. Above the MA range of 60 months (5 years) the experimental method looked definitely better than the control method in almost all areas of conservation. In both rote and rational counting the reverse was true. The heavy emphasis on one to one relationships and use of concrete objects (experimental method) was best for the MA's under 5 years but apparently was not necessary above this age and more repetition of the numerals (control method) was more advantageous. Though the pattern emerged quite clearly, interaction did not reach significance (.05).

At this point, subjects from both studies, original and replication study were combined in an AxB, by-levels design to increase the N. at each level.

Table I

MEANS AND INTERACTION BETWEEN EXPERIMENTAL AND CONTROL GROUPS ON PRE- AND POST-TEST

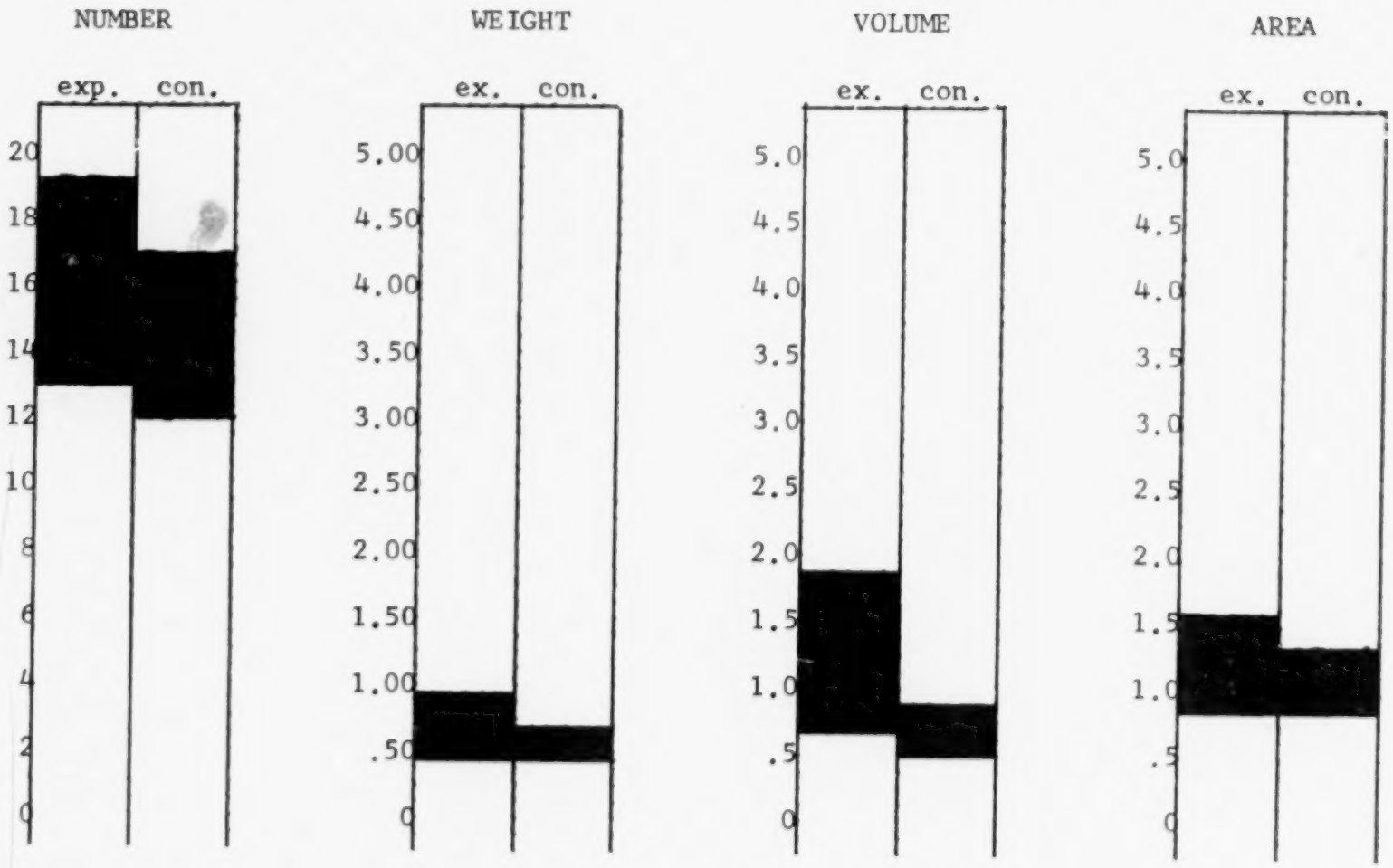
	Possible Score	Experimental (N-59) Pre-test Mean	Experimental (N-59) Post-test Mean	Control (N=34) Pre-test Mean	Control (N=34) Post-test Mean	Inter Action F(1, 92)	Main Effect Pre-Post-Test F(1, 92)
CA (months)		63.5		61.7		.57	
MA (months)		55.8		54.6		.19	
IQ (months)		86.3		86.6		.01	
Discrim. No.	5	3.00	4.10*	3.00	3.57	1.45	18.04**
Provoke Corr.	2	.69	1.47*	.91	1.20	3.54	22.04**
Unprovok. Corr.	3	1.24	1.81*	1.03	1.69*	.09	22.35**
Total Card No.	5	1.93	3.29*	1.83	2.89*	.51	38.13**
Add. Comp.	5	1.69	2.47*	1.66	2.03	.82	8.26*
Discrim. Length	5	3.25	3.37	2.91	3.57	2.04	3.08
Seriation	5	1.69	2.15	1.63	1.91	.19	4.30*
Ordinal No.	5	2.14	3.00*	1.80	2.17	1.59	12.97*
Multip. Comp	4	.68	1.41*	.91	1.29	.96	11.46*
Total Number	35	14.47	19.85*	13.74	17.43*	1.44	48.66**
Total Weight	3	.69	1.15*	.69	.97	.45	10.02*
Total Volume	6	.81	1.91*	.71	1.11	2.82	16.21**
Total Area	4	1.15	1.69*	1.06	1.51	.12	17.99**
Total Mass	3	.66	1.03*	.54	.86	.05	7.65*
Reversibility	3	1.25	1.46	1.26	1.51	.04	3.17
Total Conser.	54	17.73	25.73*	16.74	22.20*	1.74	57.37**
Rote C	20	12.93	14.10*	8.77	11.71*	3.72	16.95**
Rational C	20	5.00	9.14*	4.06	6.69*	1.25	30.00**
Transitivity	3	1.02	1.93	1.51	1.83	4.39*	24.89**

*significant difference between pre-and post-test mean (.05)

**significant (.001)

Table II

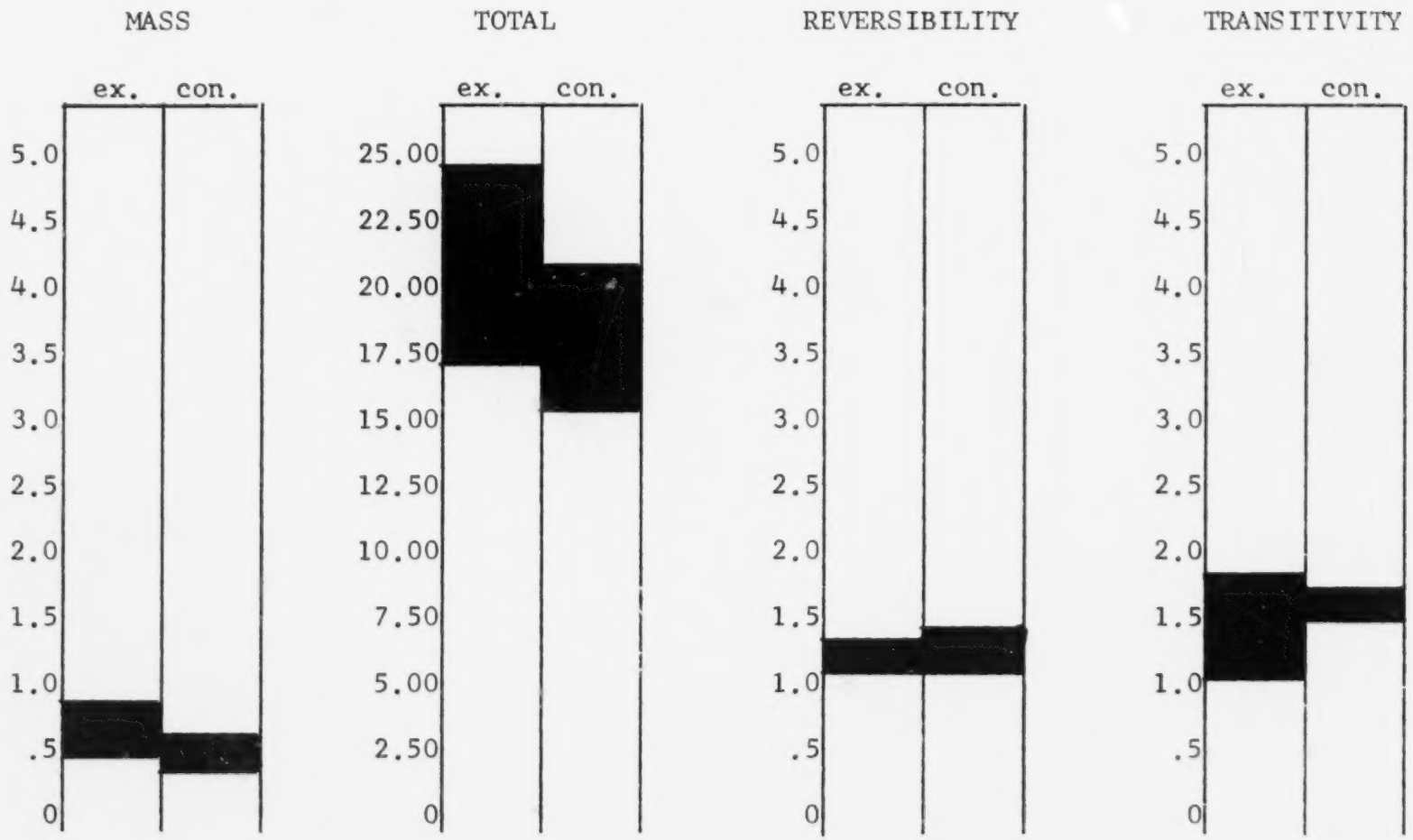
PRE-TEST AND POST-TEST MEANS IN TOTAL CONSERVATION OF NUMBER, WEIGHT, VOLUME AND AREA FOR EXPERIMENTAL AND CONTROL GROUPS



	NUMBER		WEIGHT		VOLUME		AREA	
post test mean	19.84*	17.43	post 1.15*	.97	post 1.97*	1.11	post 1.69*	1.51
pre test mean	14.48	13.74	pre .69	.69	pre .81	.71	pre 1.15	1.06

*significant gain over pre test score (.01)

Table II (Continued)
PRE-TEST AND POST-TEST MEANS IN CONSERVATION OF
MASS, TOTAL CONSERVATION, REVERSIBILITY AND TRANSITIVITY FOR EXPERIMENTAL AND CONTROL GROUPS

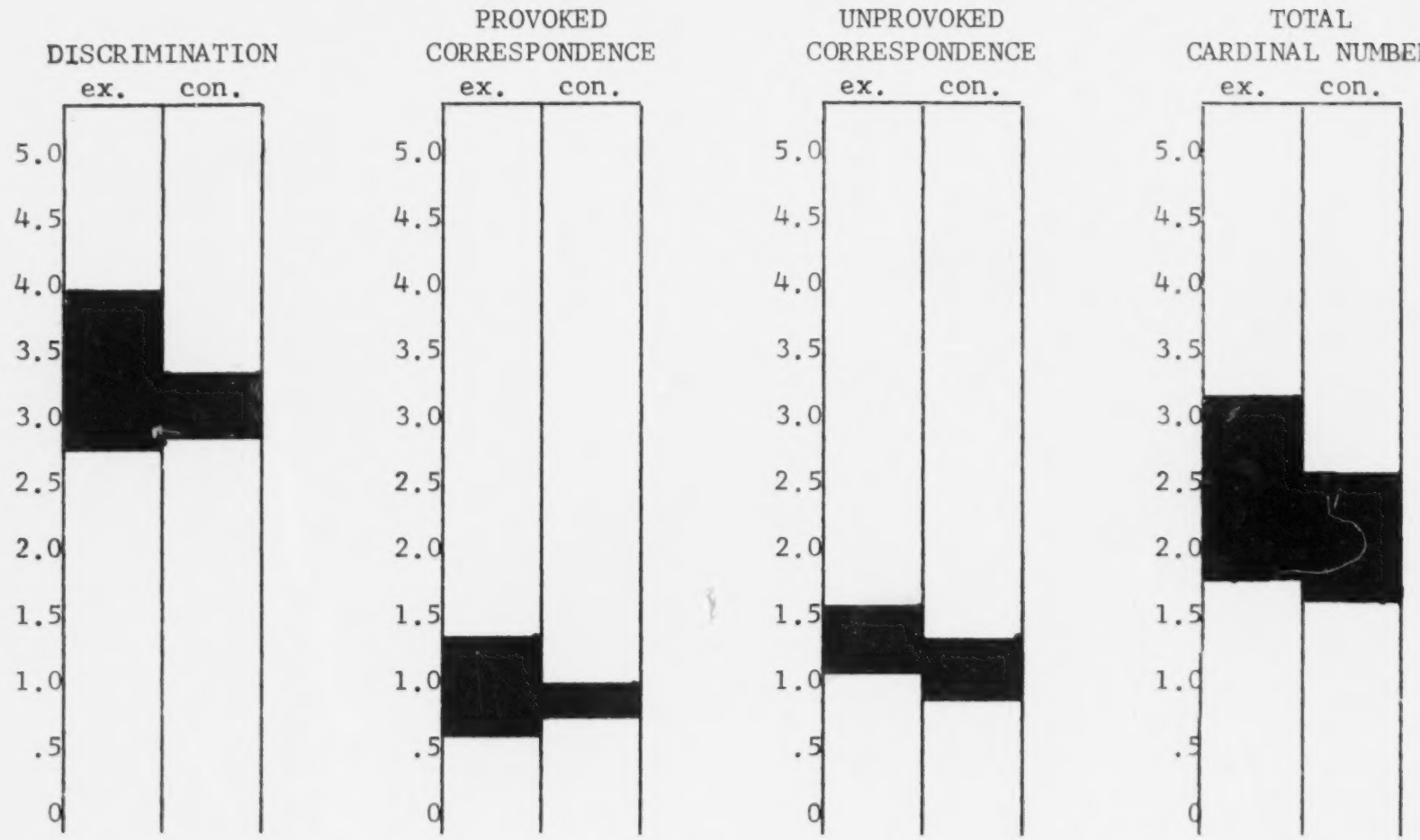


	MASS		TOTAL		REVERSIBILITY		TRANSITIVITY	
	ex.	con.	ex.	con.	ex.	con.	ex.	con.
post-test mean	1.03*	.86	post 25.73*	22.20	post 1.46	1.51	post 1.93	1.83
pre-test mean	.66	.54	pre 17.73	16.74	pre 1.25	1.25	pre 1.02	1.51

*significant gain over pre test score (.01)

Table II (Continued)

PRE-TEST AND POST-TEST MEANS IN CONSERVATION OF NUMBER FOR EXPERIMENTAL AND CONTROL GROUPS
SUBTESTS: DISCRIMINATION OF NUMBER, PROVOKED CORRESPONDENCE, UNPROVOKED CORRESPONDENCE AND TOTAL CARDINAL NUMBER

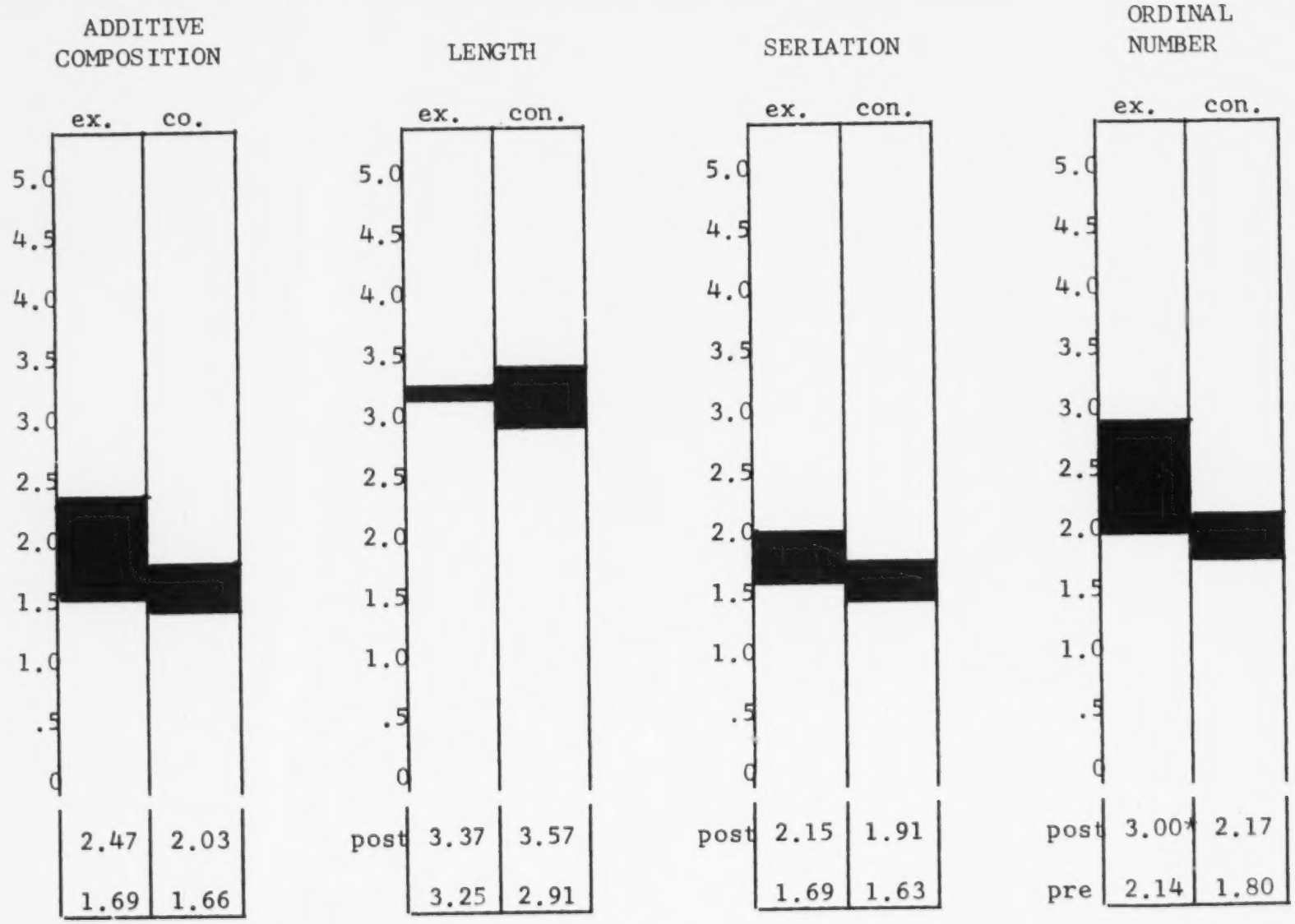


	DISCRIMINATION		PROVOKED CORRESPONDENCE		UNPROVOKED CORRESPONDENCE		TOTAL CARDINAL NUMBER	
	ex.	con.	ex.	con.	ex.	con.	ex.	con.
post-test mean	4.10*	3.57	post 1.47*	1.20	post 1.81*	1.69*	post 3.29*	2.89*
pre-test mean	3.00	3.00	pre .69	.91	pre 1.24	1.03	pre 1.93	1.83

*significant gain over pre-test score (.01)

Table II (Continued)

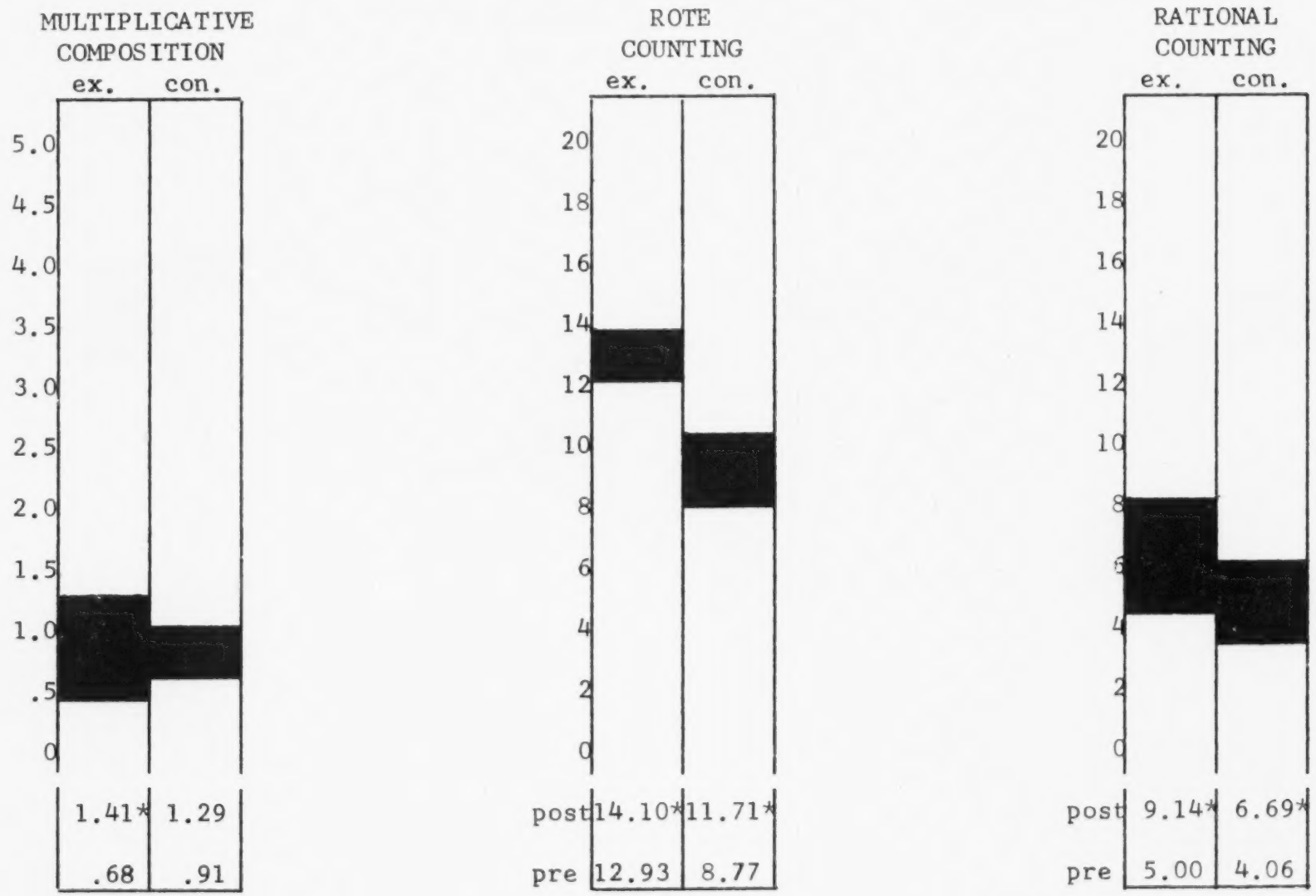
PRE-TEST AND POST-TEST MEANS IN CONSERVATION OF NUMBER FOR EXPERIMENTAL AND CONTROL GROUPS
SUBTESTS: ADDITIVE COMPOSITION, LENGTH, SERIATION AND ORDINAL NUMBERS



*significant gain over pretest score (.01)

Table II (Continued)

PRE-TEST AND POST-TEST MEANS IN CONSERVATION OF NUMBER FOR EXPERIMENTAL AND CONTROL GROUPS
SUBTESTS: MULTIPLICATIVE COMPOSITION, TOTAL NUMBER, ROTE COUNTING AND RATIONAL COUNTING



	Multiplicative Composition		Rote Counting		Rational Counting	
	ex.	con.	ex.	con.	ex.	con.
post test mean	1.41*	1.29	14.10*	11.71*	9.14*	6.69*
pre test mean	.68	.91	12.93	8.77	5.00	4.06

*significant gain over pretest score (.01)

Table III
DIFFERENCE IN GAIN BETWEEN EXPERIMENTAL AND CONTROL GROUPS
ANALYZED BY MA LEVELS

	Below 3 Yrs. mean ex	Below 3 Yrs. mean con	3-5 Yrs. mean ex	3-5 Yrs. mean con	5-7 Yrs. mean ex	5-7 Yrs. mean con	age Levels F(2,64)	Exp Con F(1,64)	Inter Action F(2,64)
Discrimination of Number-----	0.0	-.33	1.00	.89	0.00	.54	1.76	.07	.31
Provoked Correspondence------	0.0	1.33	.63	.05	.77	.38	.33	1.18	1.37
Unprovoked Correspondence----	.33	1.00	.95	1.00	.85	.23	1.03	.24	.96
Total Cardinal Number--------	.33	2.33	1.58	1.26	1.62	.62	.17	.57	1.30
Additive Composition---------	.66	.33	.37	.26	1.69	.38	.93	1.32	.66
Discrimination of Length-----	-.33	1.33	0.00	1.47	.46	-.46	1.86	2.79	5.32**
Seriation--------------------	-.33	.33	-.05	-.11	.92	.77	2.53	.01	.15
Ordinal Number---------------	.00	.33	.84	-.21	1.00	1.08	1.32	1.34	.88
Multiplicative Composition---	0.00	.33	.32+	.21	1.92	.62	2.84	1.54	1.13
Total Conservation of Number-	.66	4.67	3.95	3.63	7.77	3.77	.90	.68	1.10
Total Conservation of Weight-	.00+	.67	.63	.47	.08	-.15	1.87	.16	.35
Total Conservation of Volume-	.33	2.33	.63	.42	2.08	-.08	.74	2.59	3.62*
Total Conservation of Area---	-.33	0.00	1.00	.47	.46	.38	1.76	1.04	.51
Total Conservation of Mass---	0.00	.66	-.05	.57	.53	-.15	.04	.24	2.38
Reversibility----------------	0.00	.67	-.15	.42	.46	0.00	.11	.52	1.67
Total Conservation-----------	1.00	8.33	6.32	5.79	11.00	4.69	.43	.82	1.59
Rote Counting----------------	2.67	0.00	1.89	1.68	1.38	4.46	.53	.49	1.35
Rational Counting------------	1.00+	0.00	6.37	.89	3.77	6.46	1.67	2.24	3.91*
Transitivity-----------------	0.0+	1.00	.89	.47	1.15	.23	.05	1.94	1.08

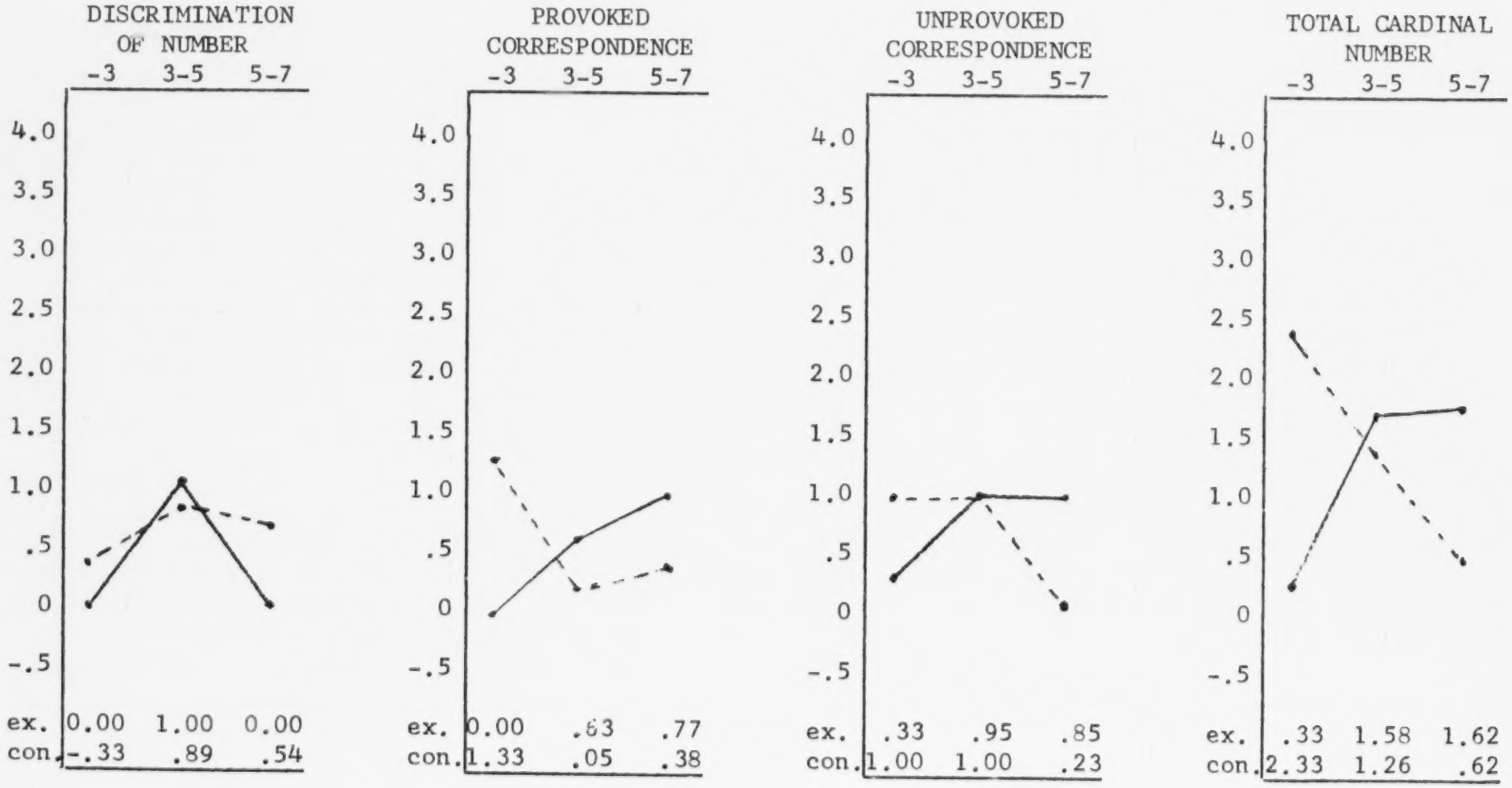
*Significant (.05)

**Significant (.01)

+Significient difference (.05) between rate of gain in experimental group at this level and level immediately older.

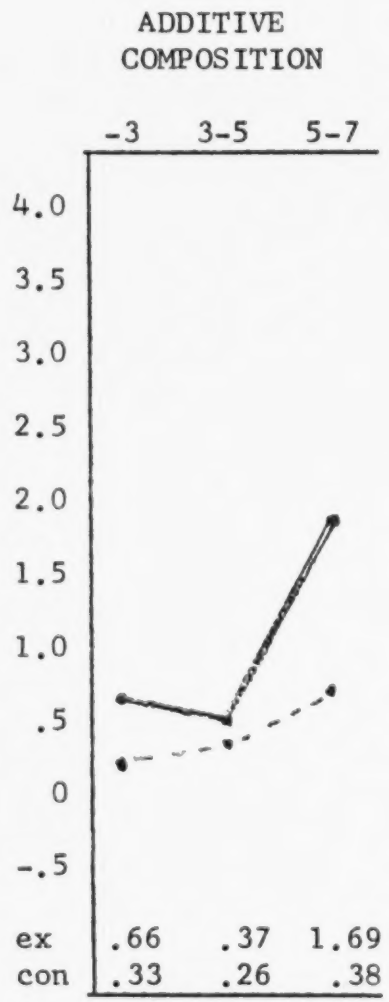
Table IV

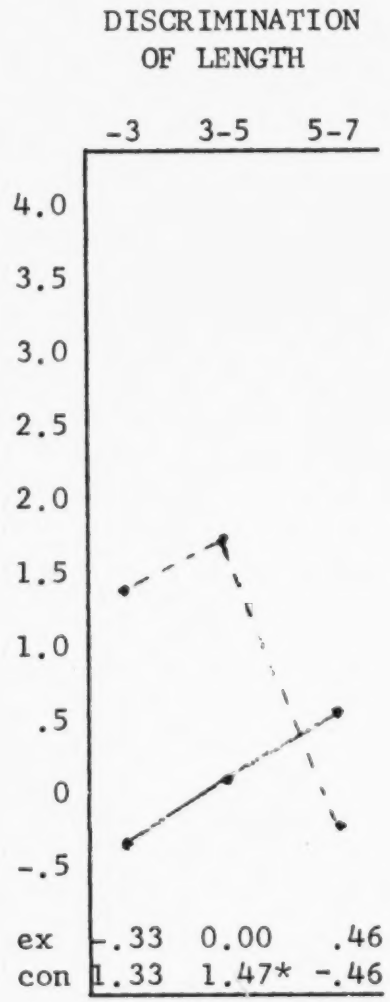
MEAN GAIN IN CONSERVATION OF DISCRIMINATION OF NUMBER, PROVOKED CORRESPONDENCE, UNPROVOKED CORRESPONDENCE, AND TOTAL CARDINAL NUMBER ANALYZED BY MA LEVELS

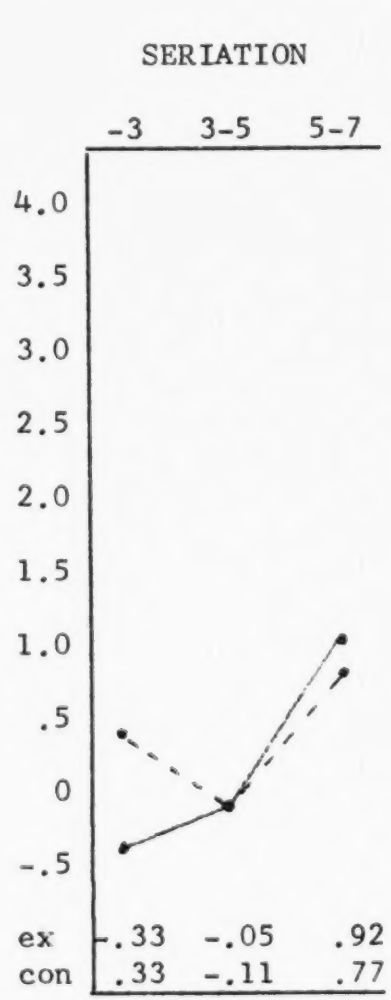


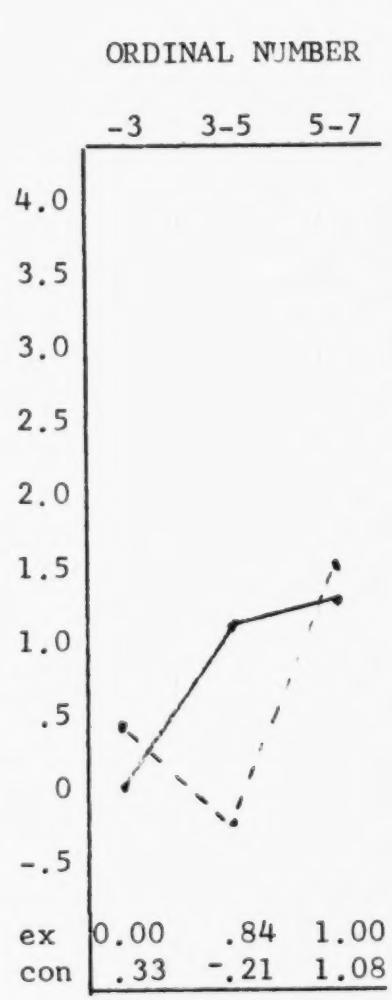
____experimental group
....control group
*significant difference in rate of gain between experimental and control groups

Table IV (Continued)
MEAN GAIN IN CONSERVATION IN ADDITIVE COMPOSITION, DISCRIMINATION OF LENGTH, SERIATION, AND ORDINAL NUMBER ANALYZED BY MA LEVELS



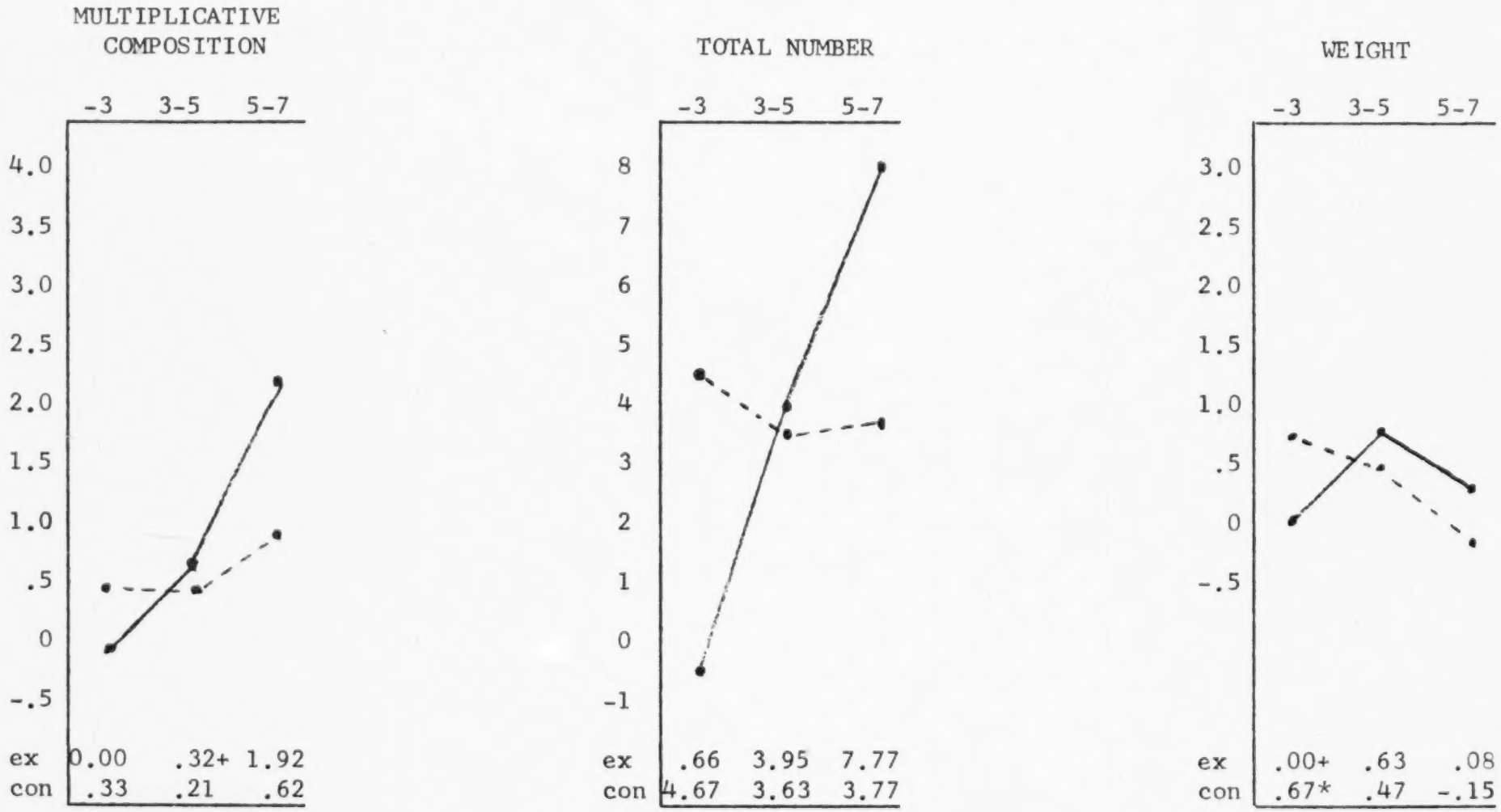






____experimental group
----control group
*significant difference in rate of gain between experimental and control groups

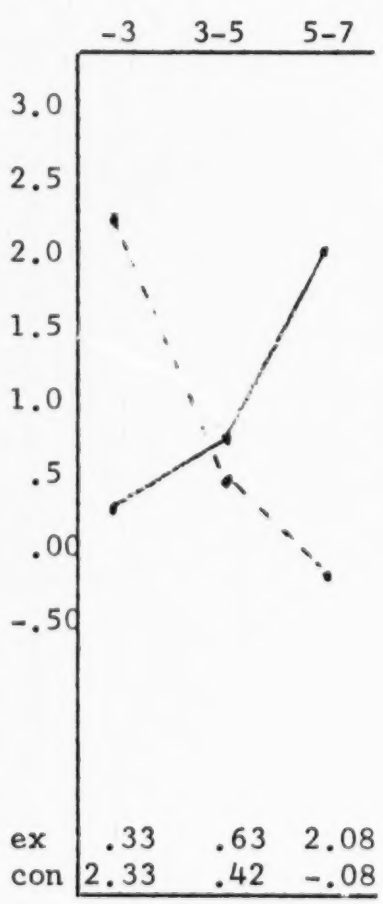
Table IV (Continued)
MEAN GAIN IN CONSERVATION OF MULTIPLICATIVE COMPOSITION,
TOTAL NUMBER AND WEIGHT ANALYZED BY MA LEVELS



____experimental group
----control group
*Significant difference in gain between ex. and con. groups
+Significant difference in gain in experimental group between levels

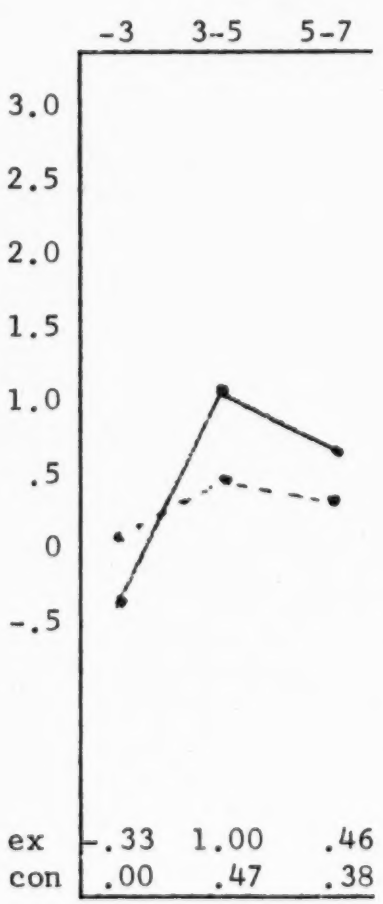
Table IV (Continued)
MEAN GAIN IN CONSERVATION OF VOLUME, AREA, MASS
AND REVERSIBILITY ANALYZED BY MA LEVELS

VOLUME



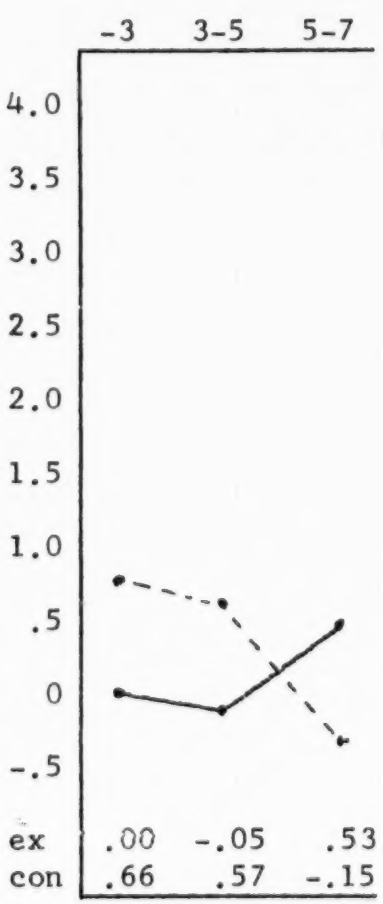
	-3	3-5	5-7
ex	.33	.63	2.08
con	2.33	.42	-.08

AREA



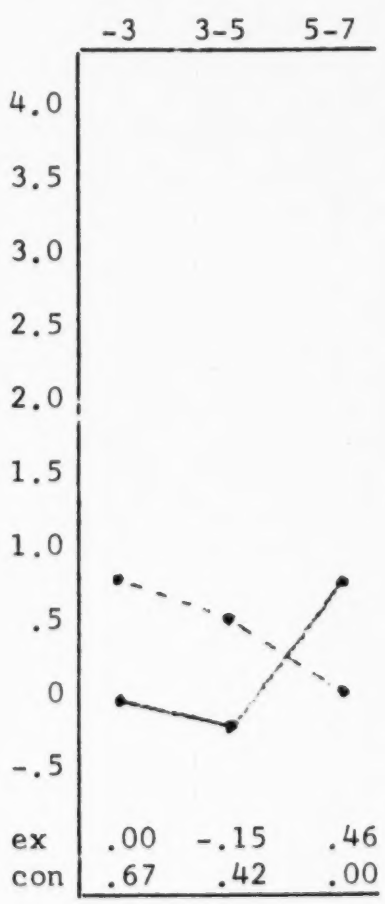
	-3	3-5	5-7
ex	-.33	1.00	.46
con	.00	.47	.38

MASS



	-3	3-5	5-7
ex	.00	-.05	.53
con	.66	.57	-.15

REVERSIBILITY



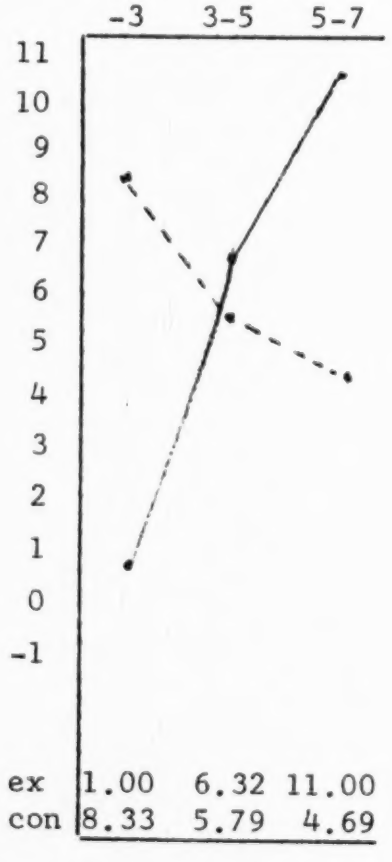
	-3	3-5	5-7
ex	.00	-.15	.46
con	.67	.42	.00

____experimental group
----control group

Table IV (Continued)

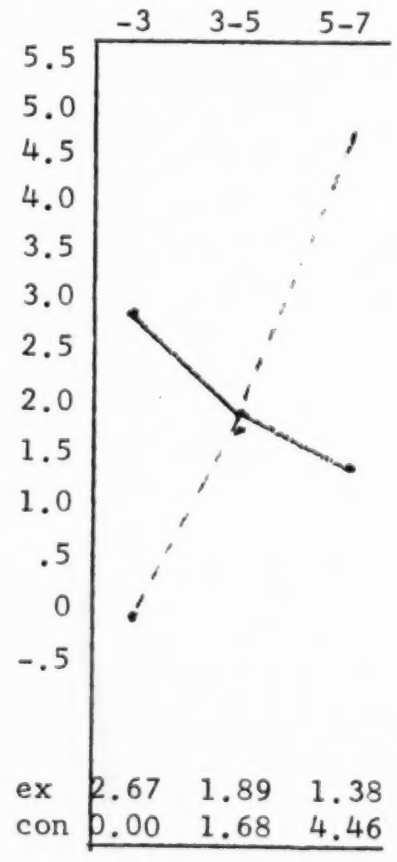
MEAN GAIN IN TOTAL CONSERVATION, ROTE COUNTING, RATIONAL COUNTING AND TRANSITIVITY, ANALYZED BY MA LEVELS

TOTAL CONSERVATION



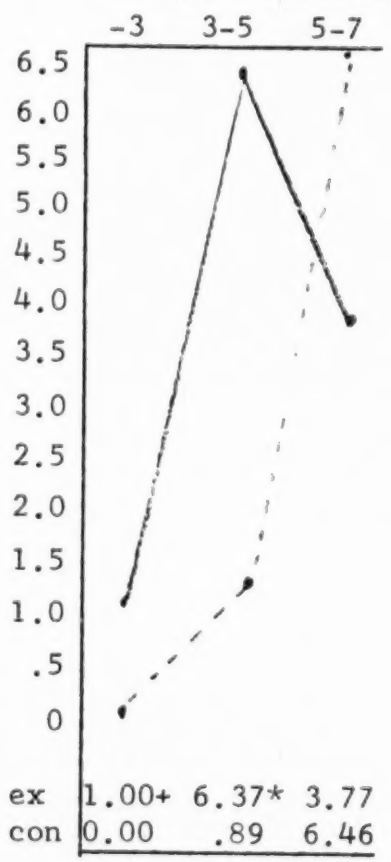
	-3	3-5	5-7
ex	1.00	6.32	11.00
con	8.33	5.79	4.69

ROTE COUNTING



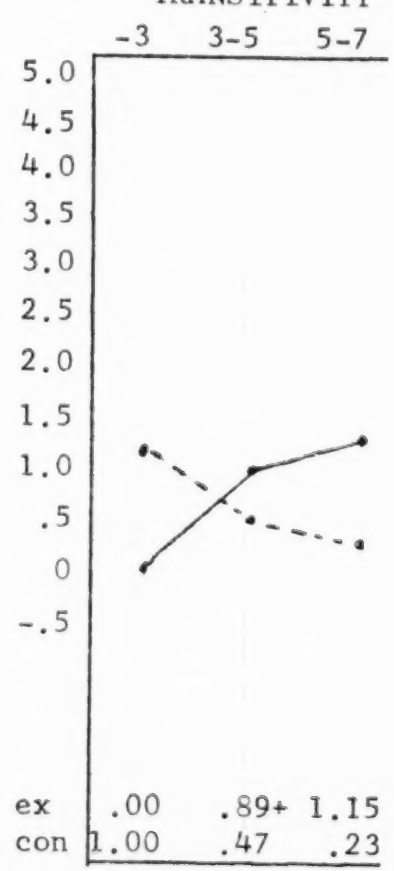
	-3	3-5	5-7
ex	2.67	1.89	1.38
con	0.00	1.68	4.46

RATIONAL COUNTING



	-3	3-5	5-7
ex	1.00+	6.37*	3.77
con	0.00	.89	6.46

TRANSITIVITY



	-3	3-5	5-7
ex	.00	.89+	1.15
con	1.00	.47	.23

____experimental group
----control group

+significant difference in gain in experimental group between level starred and level immediately older (.05)

Analysis III.

By combining the preschool children from the original study and the present replication study, it was possible to have a total N. of 154, subdivided into four MA levels: below 36 mo., 37-60 mo., 61-84 mo., and 85 mo. and over. With this number of subjects, interaction between method and MA level for total conservation, which included conservation of number, weight, volume, area, and mass was significant at the .001 level. Nine of the individual subtests also showed significant interaction between MA level and method. Tables V and VI.

Below MA 3 years, the control method was superior in total conservation and in 11 of the 17 subtests, although the difference did not in any case reach significance. At the 3-5 MA level and the 5-7 level, the experimental method was significantly better than the control method. At the 7 MA level and above, it also was significantly better in four of the more difficult subtests; additive composition, conservation of weight, volume, and area. In the easier subtests, there was no significant difference in methods at the most mature level.

Fourteen of the eighteen subtests showed a significant (.05) difference between experimental and control groups across levels (A effect). See Table V.

Four tests showed a significant (.05) difference between MA levels across Experimental/Control groups (B effect). See Table V.

Because all levels showed gain in conservation concepts and because the rate of gain was significantly affected by differences in teaching method, one may assume that conservation is largely a learning process rather than primarily biological maturation at least for the MA levels $2\frac{1}{2}$ through 9, the limits included in this study.

Since the control method showed very satisfactory gains in conservation below MA 3 years in contrast to the experimental method, one must reject the hypothesis that there is a biological limit at about MA 3 years below which conservation cannot be taught. One can only assume that the experimental method is not appropriate for use below the MA of 3 years.

It would also appear that conservation does not suddenly occur at ages 7, 9, or 12 years in the various media but is acquired gradually, bit by bit, from infancy through the years and reaches maturity, or the stage of conservation, as soon as sufficient quantity of evidence has come to the attention of the subject, which may be at age 3 or 4, (Young, 1967), if evidence is systematically brought to the attention of the child or at ages 7, 9, or 12, if this process is left to chance, or even much later in disadvantaged environments (Mead, 1960).

Since the experimental method was superior with the more difficult concepts at MA 7 years and there was no significant difference at that MA level in rate of gain in the easier concepts, implications are that when the learning task is simple, the method is not crucial but when the

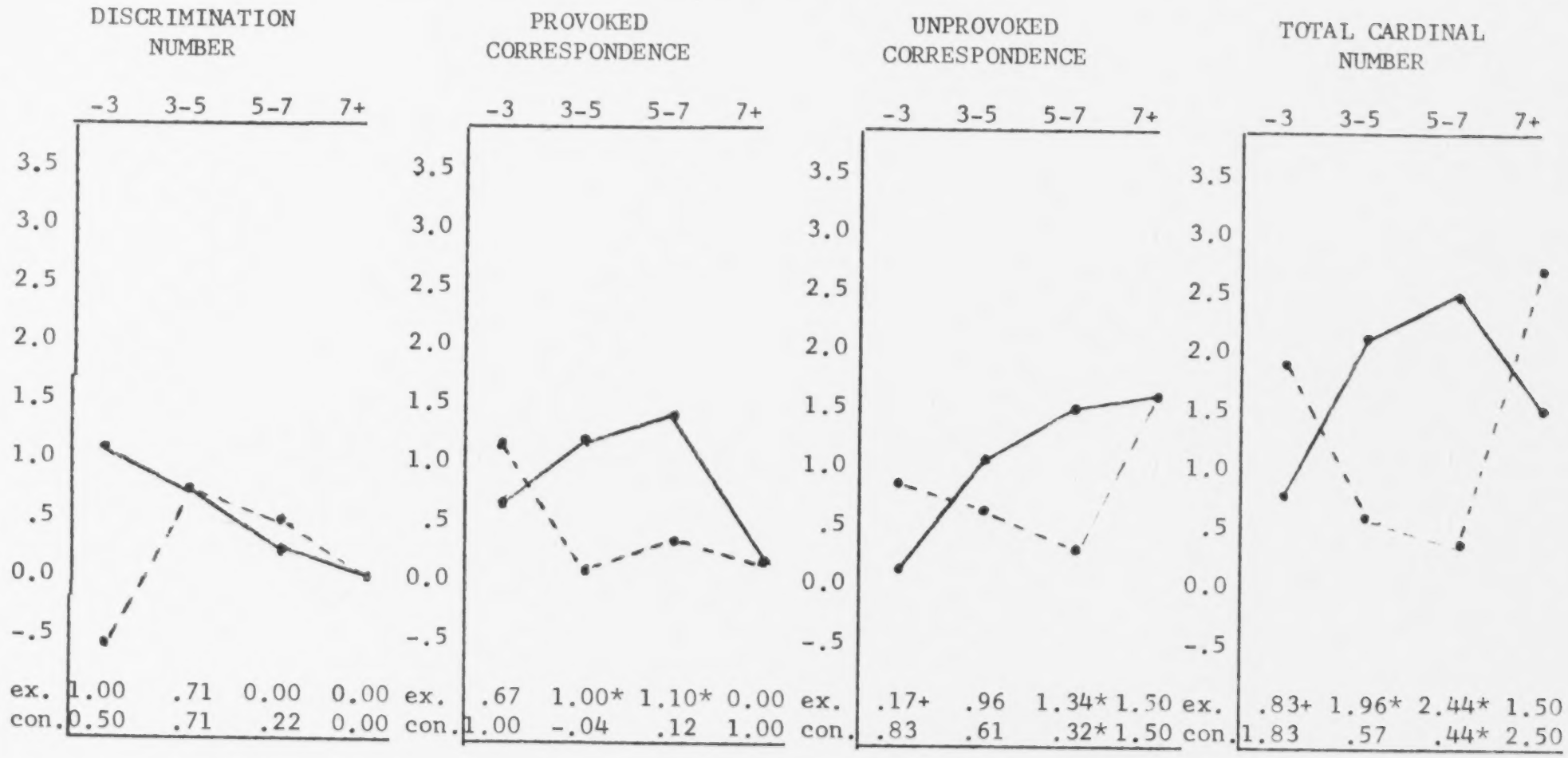
Table V
DIFFERENCES IN GAINS BETWEEN EXPERIMENTAL AND CONTROL GROUPS IN COMBINED PRESCHOOL STUDIES WHEN ANALYZED BY MA LEVELS

	MA - 3 Means		MA 3-5 Means	
	ex.	con.	ex.	con.
Discrimination of Number---------	1.00	-0.50	.71	.71
Provoked Correspondence----------	.67	1.00	1.00*	-.04
Unprovoked Correspondence--------	.17+	.83	.96	.61
Total Cardinal Number----------	.83+	1.83	1.96*	.57
Additive Composition----------	.50	.17	1.32	.79
Discrimination of Length---------	-.33	1.50	.25	.69
Seriation----------	-.33+	.33	1.00	.43
Ordinal Number----------	-.16+	.16	.89*	.04
Multiplicative Composition-------	.17	1.00	.32+	.32
Total Conservation of Number-----	1.83+	4.50	6.46+	3.50
Total Conservation of Weight-----	.33	.33	.89*	.21
Total Conservation of Volume-----	1.33	1.17	1.04+	.39
Total Conservation of Area-------	.17	.67	.82*	.18
Total Conservation of Mass-------	1.00	.33	.68	.29
Reversibility----------	.16	.33	.25	.14
Total Conservation----------	4.50	7.00	10.07*	.54
Rote Counting----------	1.33	2.33	1.89	1.50
Rational Counting----------	.50+	.33	4.14*	.25

*Significant difference in gain between experimental and control groups (.05)
+Significant difference in gain between experimental level marked and experimental level immediately older (.05)

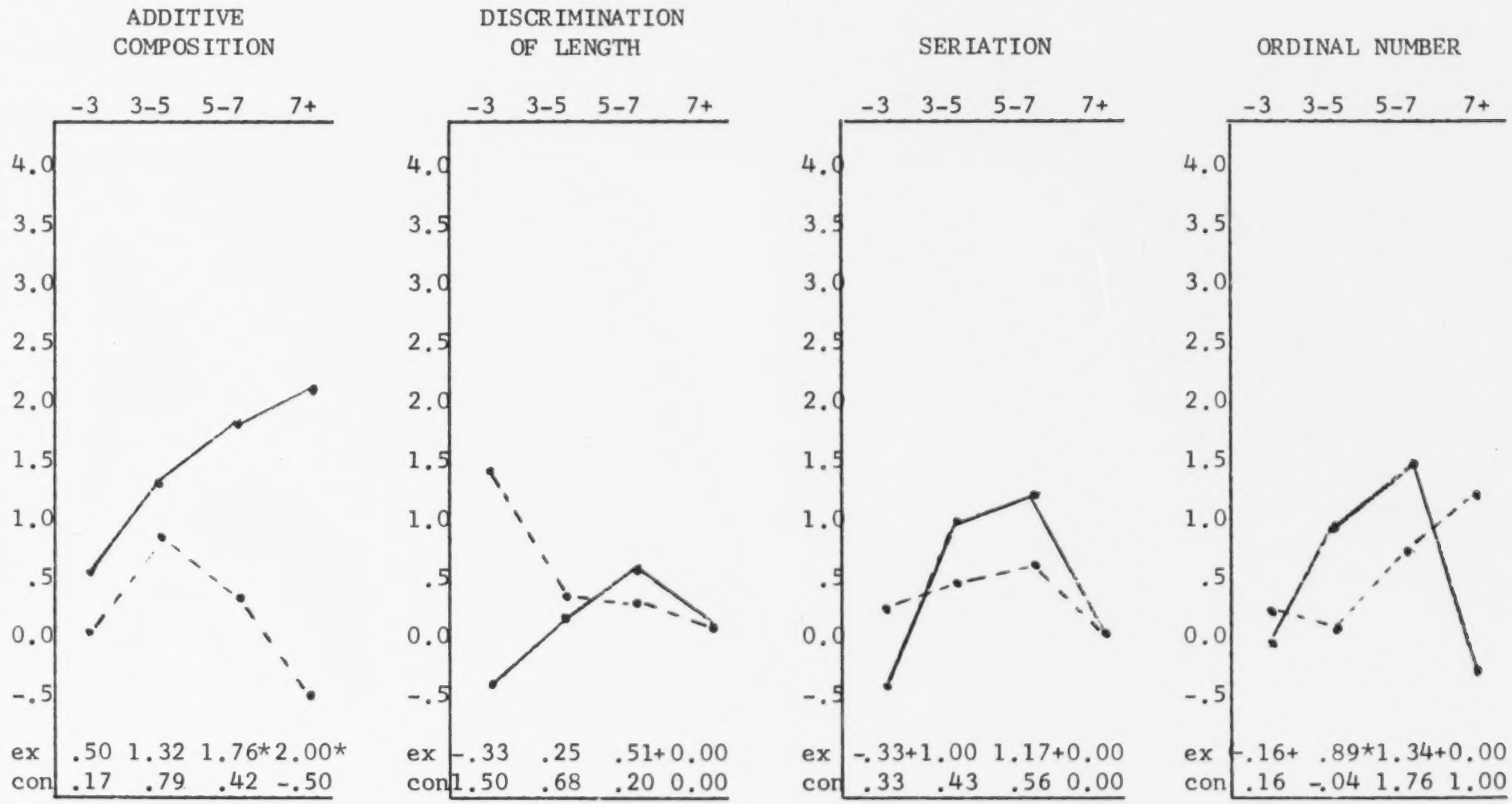
MA 5-7 Means		MA 7 + Means		METHODS	MA LEVELS	INTER-ACTION
ex	con	ex	con	(F1,146)	F(3,146)	F(3,146)
0.00	.22	0.00	0.00	0.00	2.33+	1.42
1.10*	.12	0.00	1.00	25.30*	.43	2.59+
1.34*	.32	1.50	1.50	10.48*	.73	2.26+
2.44*	.44	1.50	2.50	23.39	.18	3.11*
1.76*	.42	2.00*	-.50	10.09*	.55	.79
.51+	.20	0.00	0.00	.34	.26	2.47+
1.17+	.56	0.00	0.00	3.96*	1.49	.69
1.34+	.76	0.00	1.00	5.73*	2.78*	.93
1.93*	.15	1.50	2.00	10.93*	2.67*	4.77*
9.20*	2.78	5.00	5.00	23.64*	1.10	3.13*
1.49*	-.10	2.50*	0.00	35.69*	.75	2.96*
2.73*	.20	5.50*	.50	32.42*	3.00*	4.51*
.59	.22	1.50*	-1.00	7.86*	.15	2.49+
1.24*	.05	.50	.50	20.06*	.25	1.55
.34	.27	0.00	0.00	.18	.25	.07
15.51*	3.37	15.00	5.00	45.55*	1.35	4.11*
1.98	1.85	1.00	1.50	.04	.06	.12
5.98	3.93	7.50	5.00	11.08*	5.88*	.68

Table VI
DIFFERENCE IN GAIN BETWEEN EXPERIMENTAL AND CONTROL GROUPS IN COMBINED STUDIES WHEN ANALYZED BY MA LEVELS



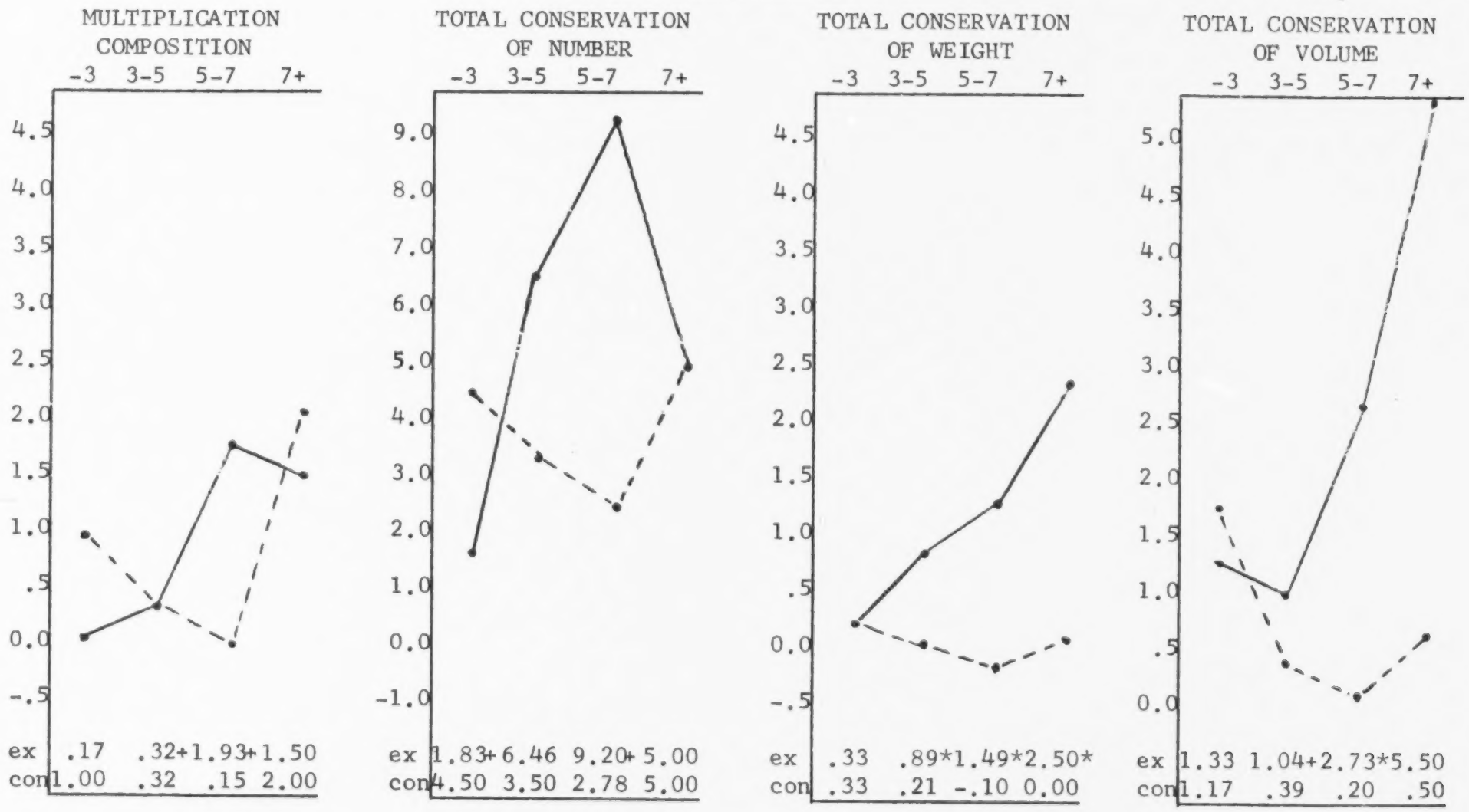
____experimental group
----control group
*significant difference in gain between experimental and control groups (.05)
+significant difference in gain between expermental level designated and experimental level immediately older (.05)

Table VI (Continued)



____experimental group
----control group
*significant difference in gain between experimental and control groups (.05)
+significant difference in gain between experimental level designated and experimental level immediately older (.05)

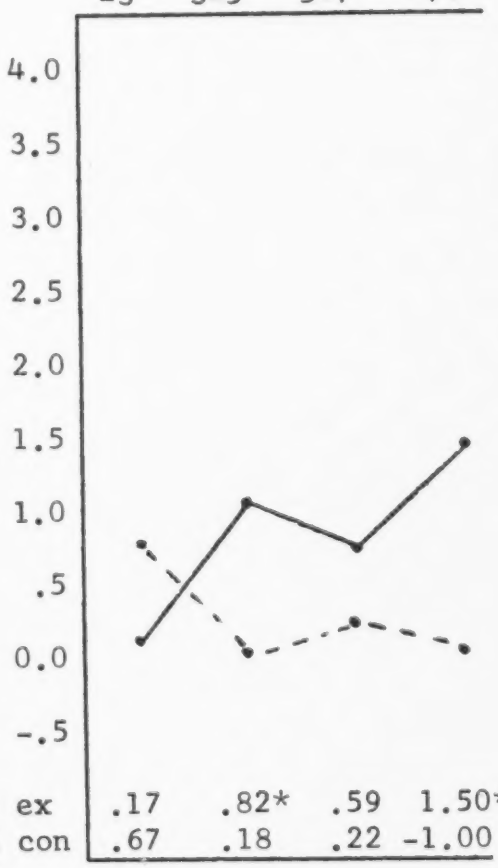
Table VI (Continued)



____experimental group
----control group
*significant difference in gain between experimental and control groups (.05)
+significant difference in gain between experimental level designated and experimental level immediately older (.05)

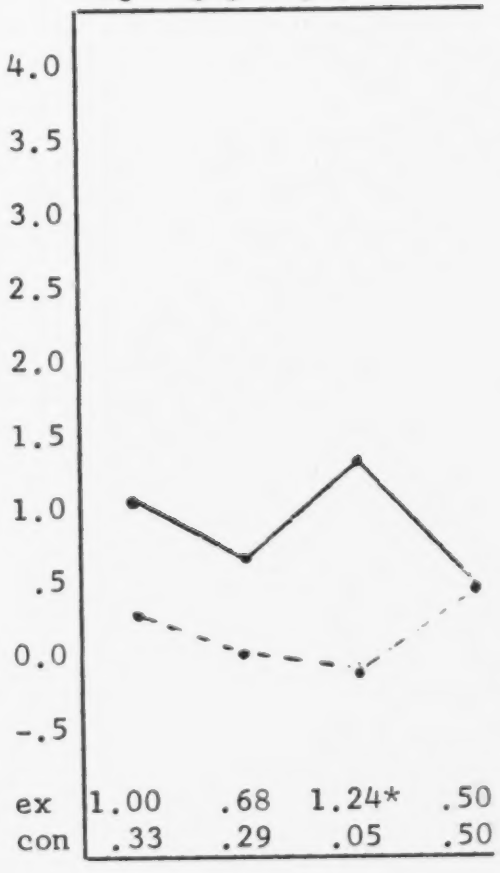
Table VI (Continued)

TOTAL CONSERVATION OF AREA



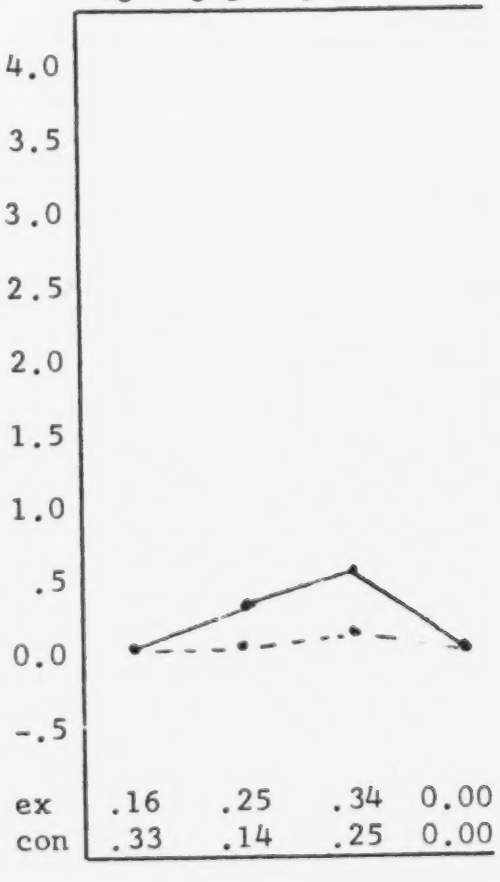
	-3	3-5	5-7	7+
ex	.17	.82*	.59	1.50*
con	.67	.18	.22	-1.00

TOTAL CONSERVATION OF MASS



	-3	3-5	5-7	7+
ex	1.00	.68	1.24*	.50
con	.33	.29	.05	.50

REVERSIBILITY

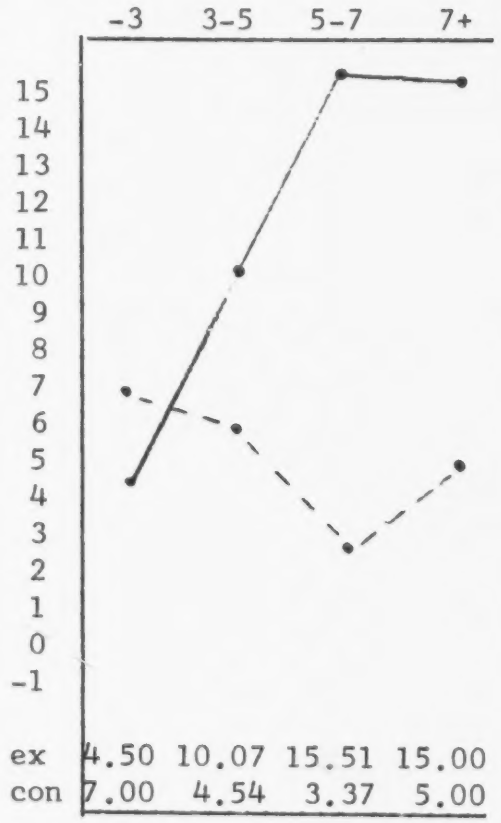


	-3	3-5	5-7	7+
ex	.16	.25	.34	0.00
con	.33	.14	.25	0.00

____experimental group
----control group
*significant difference in gain between experimental and control groups (.05)
+significant difference in gain between experimental level designated and experimental level immediately older (.05)

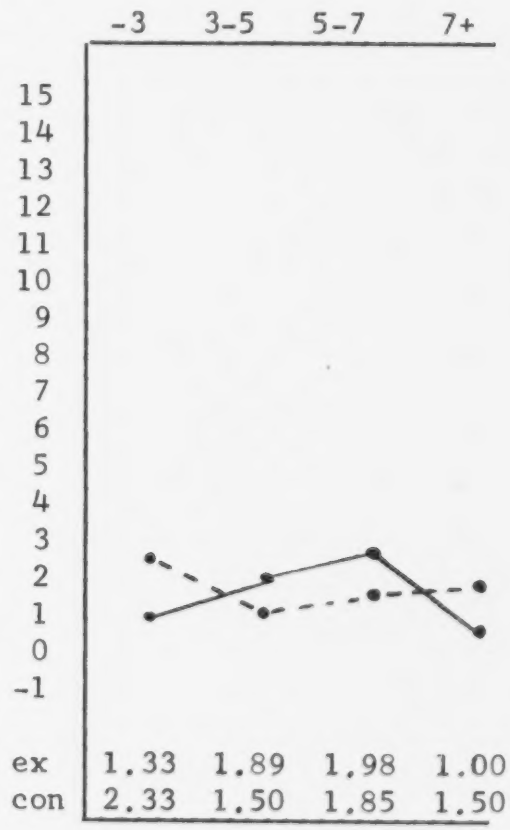
Table VI (Continued)

TOTAL CONSERVATION



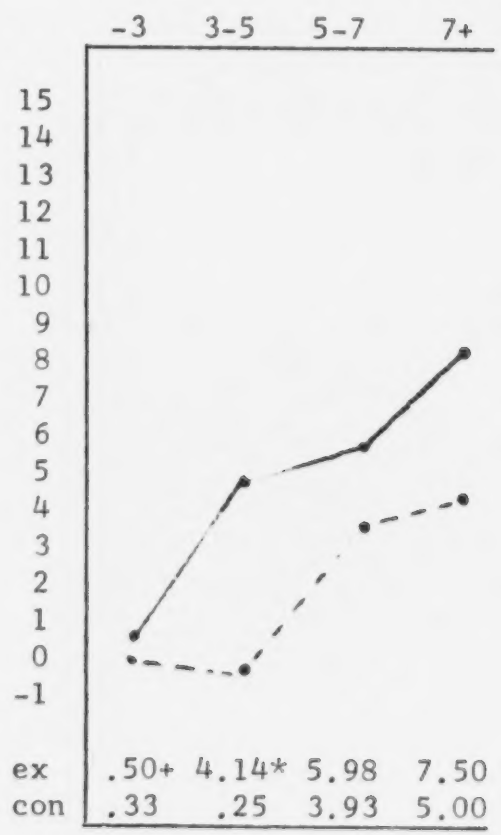
	-3	3-5	5-7	7+
ex	4.50	10.07	15.51	15.00
con	7.00	4.54	3.37	5.00

ROTE COUNTING



	-3	3-5	5-7	7+
ex	1.33	1.89	1.98	1.00
con	2.33	1.50	1.85	1.50

RATIONAL COUNTING



	-3	3-5	5-7	7+
ex	.50+	4.14*	5.98	7.50
con	.33	.25	3.93	5.00

____experimental group
----control group
*significant difference in gain between experimental and control groups (.05)
+significant difference in gain between experimental level designated and experimental level immediately older (.05)

concepts are difficult in relationship to the maturity of the student, careful structuring of the steps to discovery are quite essential.

Since the present study had not been primarily designed for the analysis of the combined studies, the above described analysis was not perfect in design. In combining the two groups of children, social class and teacher effect could not be isolated. It was felt that teacher effect was not a major source of bias as 20 or more teachers had participated, several using each method. However, since the majority of the upper MA levels had been from the advantaged group and the majority of the lower MA levels had been derived from the disadvantaged group, if a disadvantaged child of a given MA learned differently or gained differently than an advantaged child of an identical MA, bias could have entered into the above analysis. A three dimensional design Type II Design (Lindquist, 1956) was then used in an attempt to discover whether such a bias was present.

Analysis IV.

Since the combined groups were extremely biomodal, it was possible to have only two MA levels when using a three dimensional design, Type II Design (Lindquist, 1956). There were not sufficient subjects among the disadvantaged group to fill the cells in the MA levels above seven years and from the advantaged group there were too few subjects to fill the cells in the MA levels below 3 years. Therefore, no substantiation could be obtained concerning the effectiveness of the methods at the two extremes. The required proportionality of the design caused a severe loss of subjects, resulting in a total N. of 92.

In the three dimensional design, Total Conservation, which included number, weight, volume, area, and mass showed a significant difference (.001) in favor of the experimental method (A effect). Nine of the subtests also showed significant difference in favor of the experimental method. See Table VII. Total conservation also showed significant difference in rate of gain between the advantaged and disadvantaged groups (.01), C effect. In six of the subtests, this difference also reached significance. Significant (.001) interaction between method and social class (advantaged vs. disadvantaged) was also noted for Total Conservation. The experimental method was significantly better for the advantaged children at both MA levels and for the disadvantaged children in the 5-7 MA level. However, the control method showed better gains in the disadvantaged group at the 3-5 MA level.

In summary, analysis IV showed that when advantaged and disadvantaged children were matched for mental age, the advantaged children still learned significantly (.001) more rapidly. There was a significant difference in method effectiveness between social groups. While the experimental method was most effective overall (.001), it should not be used with disadvantaged children below a MA of 5 years. With the advantaged children, it was best to begin at the MA of 3 years. In other words, it should be placed in the curriculum of nursery schools for

Table VII
DIFFERENCES IN GAIN BETWEEN ADVANTAGED AND DISADVANTAGED PRE-SCHOOL GROUPS WHEN ANALYZED BY MA LEVELS

	MA 3-5 Means		MA 5-7 Means	
	Adv.	Disadv.	Adv.	Disadv.
Discrimination of Number------ex	.45	1.00	-.08	.08
con	.27	.91	.33	.58
Provoked Correspondence-------ex	1.55*	.45	1.42	.58
con	0.00	.36	.25	.33
Unprovoked Correspondence-----ex	1.73*	.27	1.92*	.92
con	.36	1.00	.33	.08
Total Cardinal Number---------ex	3.27*	.73	3.33*	1.50
con	.36	1.36	.58	.42
Additive Composition----------ex	2.27	.91	2.50	.75
con	1.18	1.00	.75	.25
Discrimination of Length------ex	1.45*	-.27	.58	.50
con	-.09	1.00	.17	-.50
Seriation---------------------ex	1.09	.18	1.42	.83
con	1.18	0.00	.83	.75
Ordinal Number----------------ex	1.91	.91	1.42	.92
con	.09	.36	.92	.92
Multiplicative Composition----ex	1.18	.09	1.75	2.08
con	.91	.55	1.00	.67
Total Conservation Number-----ex	12.09**	3.36	10.92	6.83
con	3.91	4.91	4.58	3.33
Total Conservation Weight-----ex	.91	.36	2.58**	.33
con	0.00	.73	.17	-.33
Total Conservation Volume-----ex	2.18	.82	3.00	1.25
con	.27	.27	.58	-.08
Total Conservation Area-------ex	.91	1.00	.50	.42
con	-.09	.82	.33	.42
Total Conservation Mass-------ex	1.64*	-.09	1.92*	-.08
con	.18	.73	.17	-.42
Reversibility-----------------ex	1.18*	-.09	.33	.42
con	.09	.27	.08	0.00
Total Conservation------------ex	18.91**	5.36	19.25*	9.25
con	4.27	7.36	5.83	3.92
Rote Counting-----------------ex	4.09	1.82	2.75	1.67
con	1.64	2.91	0.00	4.58
Rational Counting-------------ex	5.82	4.45	7.33	4.17
con	.82	1.09	4.58	6.17

*Significant difference between experimental and control groups (.05)

**Significant difference between experimental and control groups (.001)

Method F(1,84)	MA Levels F(1,84)	Social Class F(1,84)	Method Levels F(1,84)	Method Soc.Cl. F(1,84)	Levels Soc.Cl. F(1,84)	M x L x S F(1,84)
.31	1.88	1.56	.90	.02	.37	0.00
11.56*	.06	2.73	.06	6.88*	0.00	.36
8.43*	.01	3.75	2.72	6.66*	.16	1.54
13.99*	.00	4.67*	.89	9.66*	.08	1.29
4.33*	.49	5.81*	.62	2.35	.20	.00
2.14	1.27	1.37	.93	3.09	.01	8.18*
.32	.99	3.77	.17	.04	1.05	.31
3.88	.40	.74	1.74	1.52	.03	.30
2.17	3.83	.97	2.75	0.00	1.05	.97
11.89**	.08	7.23*	.44	6.48*	.25	2.05
15.13**	.61	7.87*	6.96*	10.03*	9.29*	.25
16.80**	.62	6.28*	.72	2.54	.47	.03
2.31	1.27	1.24	1.40	1.35	1.35	.58
8.68*	.85	16.41**	2.34	14.96**	2.20	.82
2.59	.52	1.46	0.00	1.99	1.59	3.51
22.25*	.12	11.18*	.83	12.16**	.05	1.62
.00	.17	.57	.18	6.77*	1.58	.35
4.02*	5.27*	.38	3.01	2.22	.01	.50

Table VIII
DIFFERENCE IN GAIN BETWEEN DISADVANTAGED, EXPERIMENTAL AND CONTROL GROUPS ANALYZED BY IQ LEVELS

	-65 means		66 - 80 means	
	ex.	con.	ex.	con.
Discrimination of Number--------	-2.50	-2.00	2.50	1.17
Provoked Correspondence---------	.50	0.00	1.42*	0.00
Unprovoked Correspondence-------	0.00+	.50	1.08	.91
Cardinal Number-----------------	.50+	.50	2.50	1.25
Additive Composition------------	-.50+	0.00	2.25	-.08
Discrimination of Length--------	0.00	-1.00	.75	1.66
Seriation-----------------------	0.00	0.00	.75	-.17
Ordinal Number------------------	0.00+	-0.50	1.42	-.25
Multiplicative Composition------	0.00+	0.00	1.00*	-.42
Total Conservation of Number----	-2.50+	-3.00	11.17**	2.92
Total Conservation of Weight----	1.50	0.00	.58	.83
Total Conservation of Volume----	-1.00	0.00	1.75	1.50
Total Conservation of Area------	-.50+	.50	.92	.42
Total Conservation of Mass------	0.00	0.00	.75	.92
Reversibility-------------------	-.50	0.00	.58	.50
Total Conservation--------------	-2.00+	-3.00	15.08*	6.58
Rote Counting-------------------	-2.50	4.50	1.83	1.33
Rational Counting---------------	1.50	0.00	6.50	.25
Transitivity---------------------	0.00+	0.00	1.25	.42

+significant difference between levels of experimental groups (.05)
*significant difference between experimental and control groups (.05)

32

81-100 means		100-120 means		Method ex/con	Levels	Interaction method/level
ex	con	ex	con	F(1,64)	F(3,64)	F(3,64)
1.07	.73	.43	.86	1.16	5.87	.81
.87	.27	1.00	-.86	7.84*	.08	1.00
.80	.67	.14	.14	.07	1.42	.08
1.66	.93	1.14	1.00	2.62	.90	.29
1.27	.13	0.00	1.43	3.98	.55	2.78
0.00	.33	-.57	-.14	1.36	3.22*	.40
.80	0.00	.14	1.86	.54	.61	1.97
1.53	.33	.86	1.28	6.44*	.84	1.23
1.40	.87	1.71	.42	6.14*	1.67	.50
7.60	3.53	3.71	6.71	7.45*	3.02*	2.67
1.13	.06	.42	0.00	3.29	.52	1.49
1.73*	-.20	.86	-.14	4.31*	1.90	1.05
1.00+	.27	0.00	1.00	.70	.44	2.39
.47	.26	.29	-.29	.21	1.50	.26
.33	.27	.14	0.00	.03	.66	.07
12.47*	4.20	5.43	9.00	8.50*	3.15*	2.08
1.00	1.40	2.14	5.57	.94	1.15	1.13
4.40	3.07	4.00	7.43	2.44	.99	2.30
1.53*	.40	1.14	.42	7.52*	.59	.24

advantaged children but should not be used until the Kindergarten or First grade year with disadvantaged children.

The assumption that if advantaged children were matched in MA with disadvantaged children, there would be no difference in learning ability and that the same methods would be effective with both, had to be rejected. In both cases a significant difference still exists.

In general, however, the findings of analysis III were substantiated. The only difference being that the grade placement of the experimental method should be placed at the 5-7 MA level rather than at the 3-5 MA level.

In contrast to the above findings, the conservation lessons proved to be the most effective means of teaching rational counting to the disadvantaged child at the 3-5 MA level.

It had been hypothesized that there might be interaction between IQ levels and method. It also had been hypothesized that there would be a difference in learning rate between IQ levels. Therefore, the data were analyzed by IQ levels.

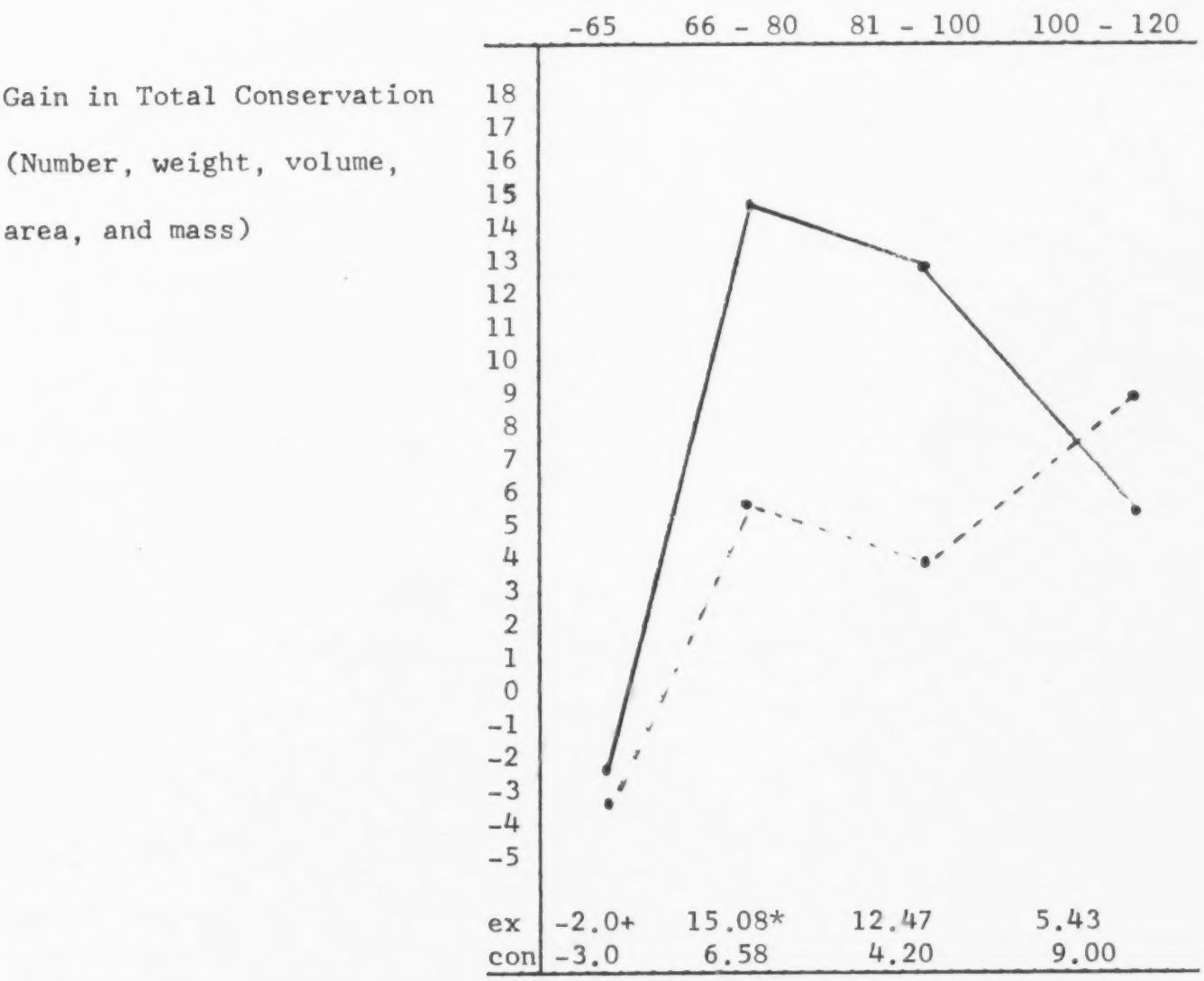
Analysis V.

When analyzed by IQ levels (total N. = 72), there was a significant difference between IQ levels, and also between methods. There was no significant difference in the methods in the level below IQ 65, however, the experimental method was significantly (.05) more effective at the 66-80 level than at the lower level and was also significantly (.05) better than the control method in Total Conservation at the IQ levels 66-80, and 81-100. See Table VIII. At the upper level, the control method again looked somewhat better but the difference was not significant. See Tables VIII and IX.

Analysis VI.

When the two social groups (advantaged and disadvantaged) were combined to increase the total N. (total N. = 168), a different picture emerged. The experimental method was still most effective at the IQ level below 65 but the reverse was true at the IQ level 65-80, though neither difference was significant. In the IQ levels, 81-100, and 100-120 and 120 and above, the experimental method was significantly more effective. Most of the subtests also showed this pattern. See Tables X and XI. It seems that there might be a different learning pattern between social classes at the 65-80 IQ level and at the 100 and over level so the data was reanalyzed using a cube design, Type II Design, (Lindquist, 1956) to eliminate the error factor which might be present due to social class.

Table IX
DIFFERENCE IN GAIN IN CONSERVATION BY DISADVANTAGED CHILD
WHEN ANALYZED BY IQ LEVELS



ex	-2.0+	15.08*	12.47	5.43
con	-3.0	6.58	4.20	9.00

____experimental group

----control group

+significant difference in gain between levels of experimental groups (.001)

*significant difference in gain between experimental and control groups (.05)

35

Table X
DIFFERENCE IN GAIN BETWEEN EXPERIMENTAL AND CONTROL GROUPS IN COMBINED STUDIES ANALYZED BY IQ LEVELS

	-65 means		65 - 80 means	
	ex	con	ex	con
Discrimination of Number	0.00	2.00	1.27	1.18
Provoked Correspondence	1.50**	0.00	.67	.36
Unprovoked Correspondence	0.00	.50	1.09	.91
Cardinal Number	1.50	.50	1.73	1.27
Additive Composition	0.00	0.00	.82	-.18
Discrimination of Length	.50	-1.00	-.18	1.64*
Seriation	0.00	0.00	-.73+	-.27
Ordinal Number	-.50	-.50	-.36	-.27
Multiplicative Composition	.50	0.00	.55*	-.45
Total Conservation of Number	2.00	-3.00	3.09	2.64
Total Conservation of Weight	2.00*	0.00	.36	.82
Total Conservation of Volume	2.00	0.00	.18	1.64
Total Conservation of Area	.50	.50	.82	.45
Total Conservation of Mass	1.00	0.00	.45	.91
Reversibility	0.00	0.00	0.00	.55
Total Conservation	7.50	-3.00	4.81	6.45
Rote Counting	-2.50	4.50	.55	1.82
Rational Counting	0.00	0.00	2.27	-.64

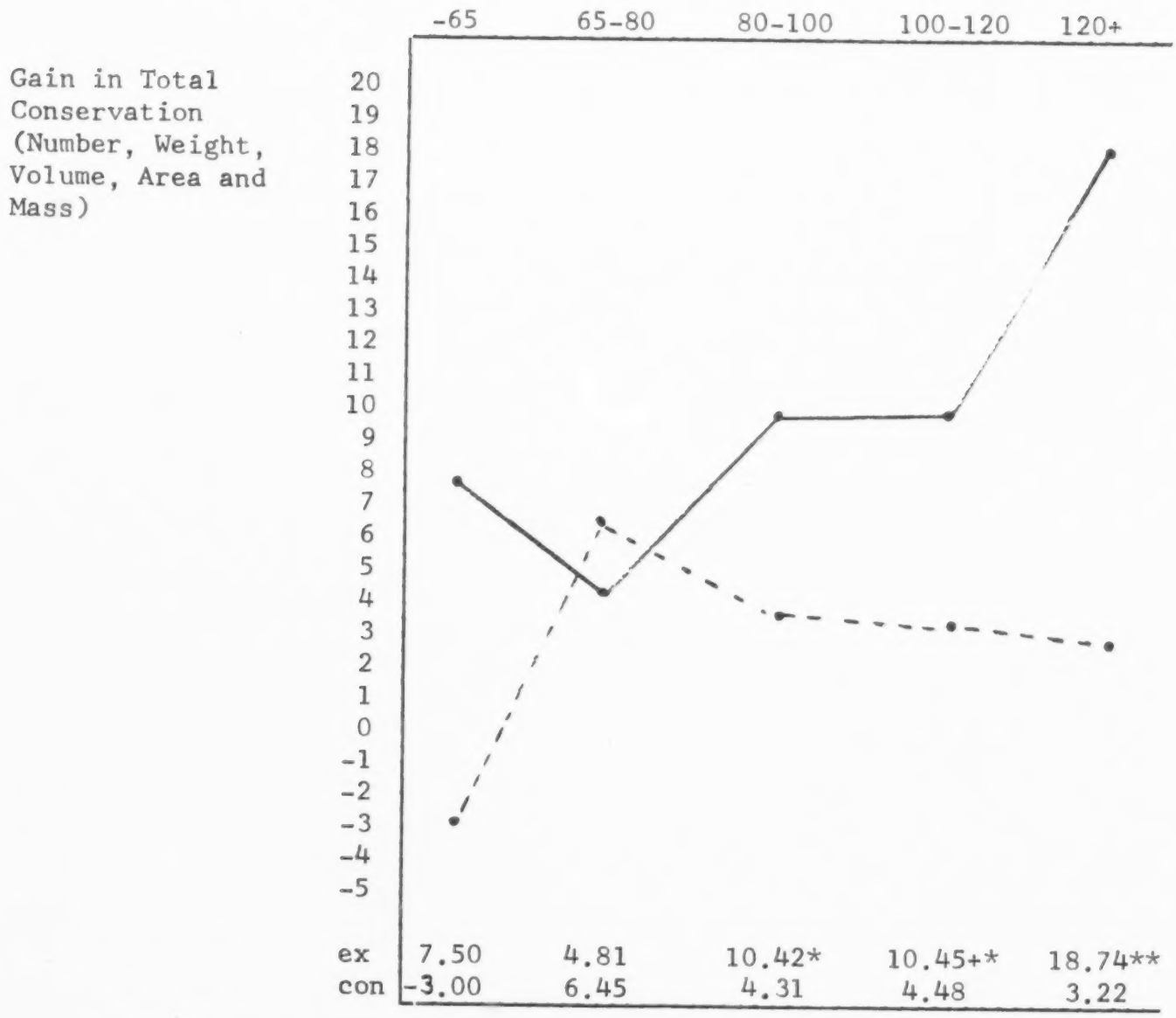
*significant (.05)
**significant (.001)
+significant difference in rate of gain at level designated and level immediately higher in experimental group (.001)

36

80 - 100 means		100 - 120 means		120+ means		method ex/con	levels	Interaction method/level
ex	con	ex	con	ex	con	F(1,158)	F(4,158)	F(4,158)
.95	.53	1.00	.17	-.04	.17	.12	5.17**	.88
.79	.21	.90*	.07	1.35**	.22	23.00**	.63	.81
.79	.58	.66	.24	1.69*	.39	8.17*	1.82	1.52
1.58	.79	1.55*	.45	3.04**	.61	19.16**	1.30	1.45
1.16	.37	1.21	1.21	2.35**	.09	10.43*	1.50	2.45
.16	.05	.83	.48	.57	.13	.08	1.50	3.29*
.89	.58	.59	.79	1.09	.48	.22	3.43*	.73
1.16	.58	1.34*	.59	1.61	.74	6.05*	3.99*	.39
.53	.74	1.48*	.52	1.61*	.17	9.62*	1.44	1.27
6.42	3.79	7.14**	4.17	10.35**	.39	21.42**	2.62*	2.29
1.05*	0.00	.34+	-.21	2.13**	.04	34.10**	5.73**	6.06**
1.32*	-.05	1.66**	.07	3.43**	.43	31.62**	3.55*	5.93**
.74	.37	.38	.17	1.04	.22	7.12*	.97	.64
.58	.21	.69+*	.06	1.65**	.17	17.81**	2.23	3.22*
.16	.21	.34	.07	.13	.30	.06	.08	.87
10.42*	4.31	10.45+*	4.48	18.74**	3.22	42.18**	2.92*	5.29**
1.63	2.11	1.79	2.72	2.13	.09	.12	.73	2.00
6.05+	2.47	4.03+	3.72	6.26*	2.57	8.28*	2.53	.94

Table XI

DIFFERENCES IN GAIN IN CONSERVATION IN
COMBINED STUDIES WHEN ANALYZED BY IQ LEVEL



____experimental group
----control group
*significant difference between experimental and control group (.05)
**significant difference between experimental and control group (.001)
+significant difference between in rate of gain at levels designated and level immediately higher in experimental group (.001)

38

Analysis VII.

Again the extreme contrast in the two groups allowed only 2 IQ levels to be formed for the three dimensional analysis, IQ levels 80-100 and 100-120, (total N. = 52).

The analysis substantiated the previous analysis in that overall, the experimental method was significantly superior (.001) and that there was significant interaction (.001) between method and social class. The experimental method produced greater gains for the disadvantaged child in the IQ level 80-100 than at the 100-120 level. This was not true for the advantaged child though the differences between levels were not significant. The control method (enriched environment) was much more effective with the disadvantaged child than it had been with the advantaged child. See Table XII.

In this analysis, there was still a possibility of considerable error. Though subjects were randomly assigned to their appropriate IQ levels, there remained a significant (.001) difference between social classes in IQ, CA, and also MA. The disadvantaged children averaged 12 months older in CA, 8 months older in MA and $6\frac{1}{2}$ points lower in IQ. See Table XIII. Table XIV shows the extreme difference in rate of gain between advantaged and disadvantaged children though similar in IQ levels.

Analysis VIII.

When the disadvantaged children were analyzed by CA levels, no significant difference in Total Conservation appeared. One subtest, provoked correspondence, showed significant interaction, the experimental method being significantly better than the control method at the 48-60 month level. This may indicate that the experimental method is generally best begun at the CA level of 4 years, though this is slightly earlier than MA analysis had placed its optimum starting point.

Analysis IX.

When the studies were combined, the experimental method was significantly superior overall but the control method appeared superior at the CA level below 4 years. The difference was not significant, however, and the experimental method was significantly (.001) better at the CA levels 4-5, and 5-6. Many of the subtests also showed this pattern. See Table XVI. Four subtests showed significant (.05) interaction between level and method.

Analysis X.

Since in Analysis IV and VII, interaction between social group and method had been noted, in MA and IQ respectively, it seemed this also

Table XII
DIFFERENCES IN GAINS BETWEEN ADVANTAGED AND DISADVANTAGED PRESCHOOL GROUPS WHEN ANALYZED BY IQ LEVELS

		IQ 80 - 100 means		IQ 100 - 120 means	
		Adv.	Disad.	Adv.	Disad.
Discrimination of Number:	ex	.20	2.20	.13	-.25
	con	0.00	.80	0.00	.63
Provoked Correspondence:	ex	1.60	.80	1.25	.63
	con	0.00	.56	-0.13	.75
Unprovoked Correspondence:	ex	1.80	-.20	1.63	.88
	con	.60	1.20	.25	.50
Total Cardinal Number:	ex	3.40	.40	2.88	1.50
	con	.60	1.60	.13	1.25
Additive Composition:	ex	2.60	2.60	2.63	.50
	con	.60	1.00	1.00	1.25
Discrimination of Length:	ex	.60	-0.80	1.75	0.00
	con	-0.60	-0.20	.13	0.00
Seriation:	ex	2.20	.80	1.50	.50
	con	2.00	.80	.63	1.13
Ordinal Number:	ex	1.40	1.60	1.75	.88
	con	.60	.60	.38	1.38
Multiplicative Composition:	ex	1.40	.20	1.38	2.25
	con	.20	2.40	1.00	1.00
Total Conservation of Number:	ex	11.80	6.60	12.25	5.38
	con	3.40	7.00	3.25	6.63
Total Conservation of Weight:	ex	2.40	.20	1.13	-0.13
	con	-0.40	-0.20	-0.13	-0.38
Total Conservation of Volume:	ex	2.00	1.60	3.13	1.38
	con	.40	.40	.25	0.00
Total Conservation of Area:	ex	.80	.60	.50	.38
	con	.40	.80	.25	1.00
Total Conservation of Mass:	ex	2.00	-0.20	1.88	0.00
	con	0.00	-0.40	.13	-0.50
Reversibility:	ex	.60	.60	1.00	.25
	con	.20	.20	.25	-0.13
Total Conservation:	ex	19.60	8.80	19.88	7.13
	con	3.80	7.60	3.75	8.25
Rote Counting:	ex	1.80	.40	5.13	2.00
	con	1.80	1.00	2.75	5.88
Rational Counting:	ex	7.80	6.40	7.00	2.25
	con	2.00	5.40	3.13	8.63

Method F(1,44)	IQ Levels F(1,44)	Social Class F(1,44)	Interaction Method Levels F(1,44)	Interaction Method Soc.Cl. F(1,44)	Interaction Level Soc.Cl. F(1,44)	Interaction MxLxS F(1,44)
.04	2.78	2.44	2.11	.04	2.48	1.85
6.45*	.01	.01	.22	6.45*	.52	0.00
1.89	.01	1.35	1.70	4.92*	.36	1.14
5.35*	.01	.75	.41	8.35*	.64	.47
3.37	44	.91	1.60	2.38	1.12	.84
3.37	4.35*	5.26*	.55	6.36*	.40	.02
.06	1.19	2.05	0.00	1.20	1.25	.48
1.85	0.00	.03	.25	1.41	0.00	1.24
.32	.41	.73	1.39	.51	0.00	3.70
5.94*	.04	.74	0.00	9.07*	.08	.05
13.14**	1.51	8.11*	1.94	6.70*	.17	1.31
16.83**	.04	2.37	.61	1.43	.75	.35
.07	.15	.59	.22	1.65	.12	.05
14.90**	0.00	19.30**	0.00	6.40*	.01	.21
2.87	.03	1.37	.07	.15	.86	.10
12.77**	.01	3.09	.04	13.53**	.02	.09
.21	4.39*	.12	.03	2.67	.18	1.21
.10	.01	.13	1.81	5.88*	.03	.62

Table XIII
MEAN CA, MA, AND IQ OF ADVANTAGED AND DISADVANTAGED PRESCHOOL GROUPS WHEN ANALYZED BY IQ LEVELS

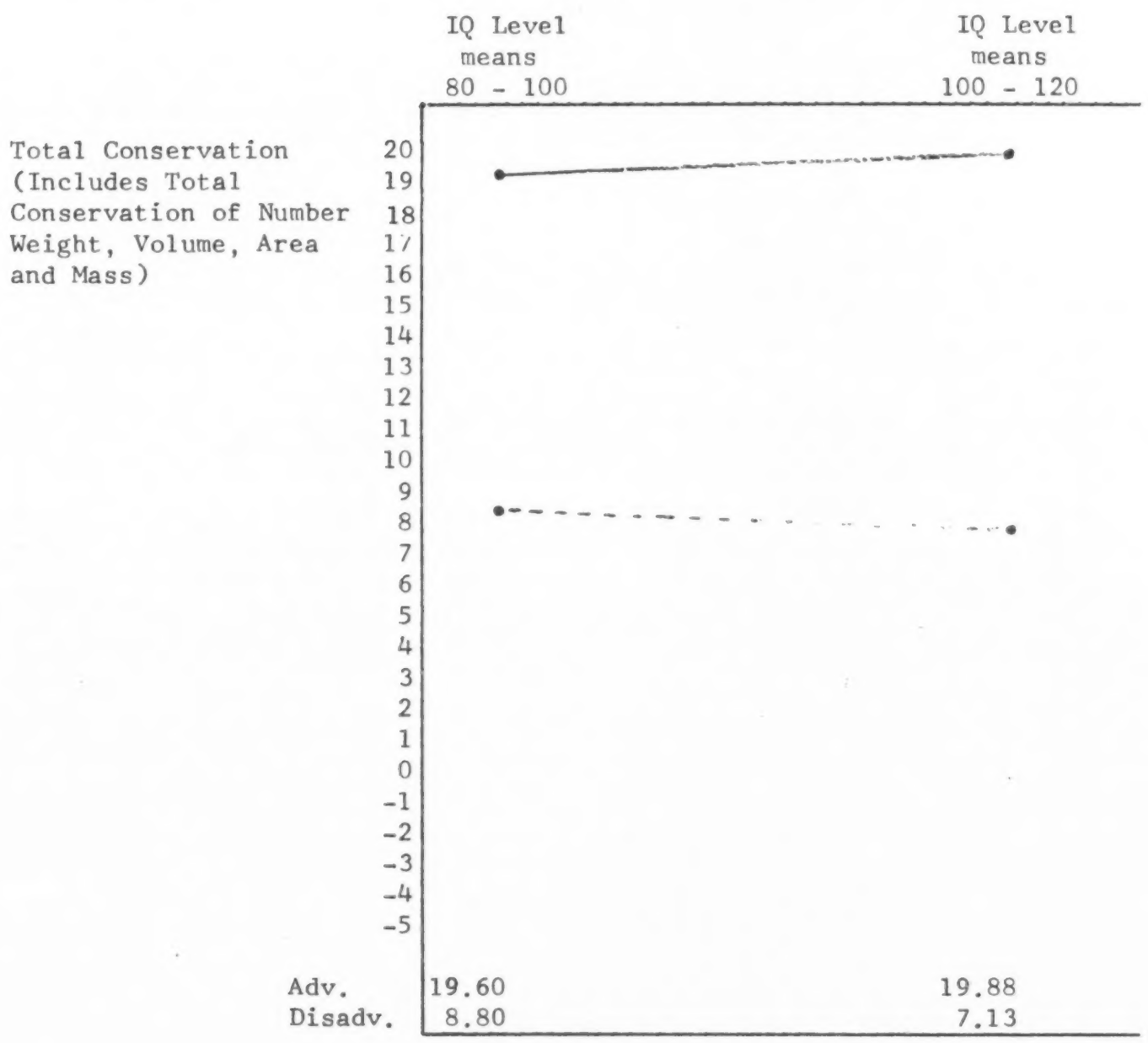
Total N = 52

	means Adv.	means Dis.	means Adv.	means Dis.	Method F(1,44)	Levels F(1,44)	Social Class F(1,44)	Interaction Method Level F(1,44)	Interaction Method Social Class F(1,44)	Interaction Level Social Class F(1,44)	Interaction MxLxC F(1,44)
Mean CA ex.	55.2	59.6	54.30	67.5	.37	1.03	22.82**	.42	.01	.29	2.50
con.	54.2	66.4	57.13	65.5							
Mean MA ex.	53.00	53.60	59.75	71.75	.41	23.57**	13.10**	1.17	.01	.43	4.26*
con.	52.00	62.80	62.88	67.75							
Mean IQ ex.	95.20	88.60	109.75	104.62	.50	111.60**	13.36**	.70	.50	.42	1.43
	94.60	93.80	110.12	104.37							

*significant (.05)
**significant (.001)

Table XIV

DIFFERENCE IN GAIN IN CONSERVATION BETWEEN SOCIAL CLASSES WHEN ANALYZED BY IQ LEVELS



____advantaged group
----disadvantaged group

43

Table XV
DIFFERENCE IN GAINS BETWEEN DISADVANTAGED EXPERIMENTAL AND CONTROL GROUPS
ANALYZED BY CA LEVELS

	CA below 50 Mo means		CA 51-60 Mo means		CA 61 Mo and Over means		method ex/con	CA level	Interaction method/level
	ex	con	ex	con	ex	con	F(1,66)	F(2,66)	F(2,66)
Discrimination of Number	1.86	0.00	2.17	1.33	.48	.39	1.49	2.28	1.16
Provoked Correspondence	.86	1.28	1.17*	.83	.52	.26	2.10	2.16	3.46*
Unprovoked Correspondence	.30	1.00	.83	1.00	1.00	.60	.08	.16	1.14
Total Cardinal Number	1.14	2.29	2.00	.83	1.52	.86	.66	.36	1.32
Additive Composition	1.43	.29	.33	.50	.87	.35	1.10	.14	.30
Discrimination of Length	-.86	1.43	0.00	1.17	.48	.48	2.71	.12	2.77
Seriation	-.14	-.14	.16	.33	.43	.52	.01	1.08	.15
Ordinal Number	.29	.43	1.67	.17	.56	.56	.37	.14	1.17
Multiplicative Composition	.43	.29	.33	-.16	1.04	.65	.71	1.02	.04
Total Conservation of Number	4.29	4.57	6.67	3.17	5.48	3.83	.88	.02	.22
Total Conservation of Weight	.43	.86	.50	0.00	.52	.26	.34	.36	.56
Total Conservation of Volume	1.71	1.43	.83	1.50	.87	0.00	1.23	2.19	.79
Total Conservation of Area	.71	.43	.67	-.17	.52	.48	.61	.26	.51
Total Conservation of Mass	.57	1.00	0.00	.67	.13	.04	.25	1.89	.61
Reversibility	0.00	.86	0.00	.33	.04	.17	1.23	.40	.52
Total Conservation	7.57	8.28	8.50	5.83	7.74	5.13	.75	.14	.17
Rote Writing	2.29	-.14	.17	-1.17	1.43	3.74	.49	2.25	1.72
Rational Counting	.71	0.00	3.83	4.00	5.39	3.56	.83	2.61	.15
Transitivity	.71	1.29	1.33	.50	.91	.13	2.40	.78	1.26

*Significant difference between experimental and control groups (.05)

might appear in CA. If it did, there would then be an easier method of determining classroom placement of the curriculum materials. Albeit, not as precise. An Analysis of Variance, Type II Design (Linquist,1956) was used. Methods, being the A factor, CA levels, the B factor, and Social Class the C factor. Gain scores were again used to avoid the necessity of a four factorial design. In total conservation, the experimental method was significantly better (.001). However, the interaction between social class and CA level was also significant (.001). For advantaged children, the experimental method was better at every age level but with the disadvantaged children, it should not be used until age 5. At CA 5 and above the experimental method was best for disadvantaged children but until that age the control (enriched environment) was preferable for deprived children. See Table XVII.

Table XVIII shows that after stratification, the mean CA, MA, and IQ for each subgroup was determined to verify equivalance by CA of levels. The significance between levels was as expected. The interaction between CA and social class indicated that in the CA level above 5 years, the disadvantaged children averaged a bit older. The significant difference in IQ between the advantaged and disadvantaged groups was not unexpected. This, of course, affected MA. The fact that at the CA of 5 the advantaged child averaged $2\frac{1}{4}$ years older mentally than the disadvantaged child is an important concept to keep in mind in curriculum development. The data verified this same difference when it indicated that brief periods of structured play (experimental method) was appropriate for use with advantaged children with a CA of 3 years but was not appropriate for use with the disadvantaged child until he had reached a CA of 5 years.

Analysis XI.

This analysis was directed toward the determining the degree of retention shown by those post-tested immediately as opposed to those post-tested 6 weeks after the termination of the teaching sessions. Twelve of the 18 tests showed the subjects who were post-tested late had greater gain in conservation than those post-tested immediately following instruction. The difference in total conservation was significant (.05).

Table XVI
DIFFERENCE IN GAINS BETWEEN EXPERIMENTAL AND CONTROL GROUPS IN COMBINED PRESCHOOL STUDIES ANALYZED BY CA LEVELS

	CA Below 4 Yrs means		CA 4 - 5 Years means	
	ex	con	ex	con
Discrimination of Number---------	.89	.33	.39	.46
Provoked Correspondence----------	.78	1.11	1.07*	.14
Unprovoked Correspondence--------	.33	1.00	1.14*	.32
Total Cardinal Number----------	1.11	2.11	2.21*	.46
Additive Composition----------	1.56	.56	1.89*	.36
Discrimination of Length---------	-.66	1.33	.14	.50*
Seriation----------	-.11+	.56	1.36*	.21
Ordinal Number----------	.77	.11	1.57*	.21
Multiplicative Composition-------	.67	.78	.96	.86
Total Conservation of Number-----	4.33	5.78	8.46**	3.07
Total Conservation of Weight-----	.67	.33	1.18*	.04
Total Conservation of Volume-----	1.22	1.44	2.18*	.82
Total Conservation of Area-------	.44	.33	1.04*	.04
Total Conservation of Mass-------	.77	.44	1.00	.36
Reversibility----------	0.00+	.33	.53	.32
Total Conservation----------	7.44	8.33	14.21**	4.36
Rote Counting----------	2.89	2.33	2.21	.71
Rational Counting----------	1.67+	.11	5.64*	2.14

*significant difference between experimental and control group (.05)
**significant difference between experimental and control group (.001)
+significant difference between level designated and level immediately older in experimental group (.05)

46

CA 5 - 6 Years means		CA 7 Years + means		method ex/con	CA level	Interaction level/method
ex	con	ex	con	F(3,146)	F(3,146)	F(3,146)
.64	.24	2.57*	0.00	3.45	1.41	3.01*
1.12*	.24	.71	-.57	23.76**	2.08	2.27
1.03	.52	1.29	.43	7.51*	.08	1.93
2.15*	.76	2.00	.43	18.60**	.17	2.74*
.82	.64	2.57	.29	9.59*	.75	1.87
.55	.18	.29	0.00	.61	.09	3.33*
.64	.67	1.57	.14	2.96	.61	2.42
1.03	.45	.71	.57	9.61*	.36	.81
1.36*	-.12	1.29	.86	6.47*	.44	2.08
7.09*	2.73	11.00	2.71	23.50**	.57	2.30
1.27*	.09	.71	.29	24.74**	.15	.85
1.94*	.09	1.71	.71	15.88**	.55	1.19
.46	.45	1.00	0.00	7.85*	.12	2.84*
.88*	0.00	.71	.29	12.41**	.41	.33
.12	0.00	1.00	.71	.05	3.38*	.42
11.94**	3.64	15.14	4.00	38.91**	.47	2.29
1.27	2.30	-0.43	3.71	.11	.42	2.52
6.58	3.84	5.57	6.43	8.87*	3.72*	.69

Table XVII
DIFFERENCES IN GAINS BETWEEN ADVANTAGED AND DISADVANTAGED PRESCHOOL GROUPS WHEN ANALYZED BY CA LEVELS
Total N = 88

		CA below 48 mo. mean gain		CA 40-60 mo. mean gain		CA 61-72 mo. mean gain	
		adv.	dis.	adv.	dis.	adv.	dis.
Discrimination of Number---	ex.	1.50	.50	-0.17	.83	0.00	.36
	con.	.50	.25	0.00	1.83	0.00	.18
Provoked Correspondence----	ex.	1.25	.25	1.17	.67	1.00	.91
	con.	.75	1.25	.83	0.00	.09	.64
Unprovoked Correspondence--	ex.	1.00	0.00	1.00	.33	1.45	1.27
	con.	.50	1.25	.50	.67	.36	.73
Total Cardinal Number------	ex.	2.25	.25	2.17	1.00	2.45	2.18
	con.	1.25	2.50	1.33	.67	.45	1.36
Additive Composition-------	ex.	2.00	1.50	2.83	-.17	2.00	-0.18
	con.	.75	.75	1.17	.67	1.09	.45
Discrimination of Length--	ex.	-.25	-1.00	.83	-1.50	.36	0.00
	con.	1.50	1.50	.33	1.00	-.27	.27
Seriation-----------------	ex.	.50	-.25	2.17	-.17	.91	1.09
	con.	1.25	0.00	.33	-.17	.82	.73
Ordinal Number------------	ex.	1.25	.50	2.50	1.17	.36	1.18
	con.	0.00	.25	.67	.67	.64	.64
Multiplicative Composition-	ex.	1.00	.50	1.67	.67	2.00	1.00
	con.	1.50	0.00	1.17	-0.17	-.73	1.09
Total Conservation Number--	ex.	8.25	2.25	12.00	1.50	8.09	5.64
	con.	6.75	5.25	5.00	4.50	2.00	4.45
Total Conservation Weight--	ex.	1.25	.25	1.00	.50	2.45	1.00
	con.	-.25	.75	-.33	.33	.18	0.00
Total Conservation Volume--	ex.	2.25	.50	1.67	.67	4.18	.45
	con.	0.00	2.50	.17	1.67	.64	.27
Total Conservation Area----	ex.	1.00	.25	1.17	1.33	.45	.73
	con.	.75	-0.25	0.00	.17	.18	1.00
Total Conservation Mass----	ex.	1.50	0.00	1.00	-.17	1.55	.55
	con.	0.00	.75	-.17	1.00	.18	0.00
Reversibility-------------	ex.	0.00	0.00	1.33	.33	.09	.27
	con.	0.00	.50	0.00	.67	.18	-.09
Total Conservation---------	ex.	14.00	3.50	18.17	3.83	16.82	8.91
	con.	7.25	9.00	4.67	7.67	3.00	5.82
Rote Counting-------------	ex.	4.75	1.75	3.83	1.17	.82	2.18
	con.	4.25	1.00	-1.33	2.17	.27	4.36
Rational Counting----------	ex.	3.00	.75	8.50	2.00	6.73	7.27
	con.	.75	-.50	4.50	.83	5.45	4.27

*significant difference in gain between advantaged and disadvantaged group (.05)
**significant difference in gain between advantaged and disadvantaged group (.001)

48

Method F(1,72)	CA Levels F(2,72)	Social Class F(1,72)	Method Levels F(2,72)	Interaction Method Soc. Cl. F(1,72)	Level Soc.Cl. F(2,72)	MxLxS F(2,72)
0.0	1.43	1.98	.95	.22	2.71	.32
3.52	.30	.31	1.10	1.47	1.63	1.07
2.25	.73	.04	1.82	2.85	.17	.39
4.05*	.26	.18	1.95	3.13	.96	.75
1.17	.48	12.32**	.42	5.28*	1.10	.47
4.02*	.38	.78	4.59*	6.18*	.91	1.32
.72	.80	2.87	1.03	.18	1.93	1.06
2.72	1.44	0.00	.93	.05	1.02	1.17
5.40*	0.00	.67	.91	2.47	1.99	2.58
4.73*	.19	4.53	1.19	8.57*	2.65	.60
20.68**	1.83	2.49	1.90	7.24*	1.43	.18
10.05*	.39	7.55*	3.03	23.63**	6.02*	.39
3.55	.26	.60	2.73	.31	3.05	.30
4.91*	.14	2.18	1.34	8.73	.49	1.03
.69	2.22	.01	.81	.69	.25	2.61
15.61**	0.00	6.37*	2.01	18.49**	.42	.45
.12	.77	1.38	1.20	3.75	3.72*	.93
3.99*	5.80*	3.17	.03	.01	1.75	.42

Table XVIII
MEAN CA, MA AND IQ OF ADVANTAGED AND DISADVANTAGED
PRESCHOOL GROUPS WHEN ANALYZED BY CA LEVELS

Total N = 88

		CA - 48 mo. mean		CA 49-60 mo. mean		CA 61-72 mo. mean		MxLxS F(2,72)	Levels F(2,72)	Social Class F(1,82)	Level Soc. CI F(2,72)	Method Soc.CI. F(1.72)	Method Level F(2,72)	Ss(Groups) F(2,72)
		Adv.	Dis.	Adv.	Dis.	Adv.	Dis.							
Mean CA	ex	44.75	41.25	55.67	54.50	62.91	67.82	.54	265.61**	1.98	.63	.65	7.37*	.92
	con	44.50	43.50	55.67	53.67	63.09	65.36							
Mean MA	ex	49.75	48.50	64.50	60.73	75.27	52.00	1.91	48.84**	87.31**	0.05	3.02	1.77	2.09
	con	47.75	45.33	75.17	58.36	82.18	51.29							
Mean IQ	ex	127.00	79.50	116.00	88.00	121.09	88.91	2.95	3.22	99.72**	.09	2.77	2.20	1.86
	con	112.00	91.00	138.50	82.83	132.91	87.91							

*significant (.05)
**Significant (.001)

Chapter III

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

In summary, the conclusions of the study were:

1. The experimental lessons in conservation of number, weight, volume, area, and mass were effective for improving these concepts among disadvantaged children.

2. The lessons were simple enough to be taught effectively by inexperienced teachers using only printed lesson plans with no additional assistance.

3. There was a significant difference in effectiveness of the lessons at different CA, MA, and IQ levels.

4. There was a significant difference in where the lessons should be placed in the two social classes.

5. The lessons were effective with the advantaged children at all CA, and IQ levels included in this study. (CA 3-6 years, IQ 60-167) and in all MA levels above 3 years (MA 3-9). It was not effective when the MA was below 3 years. There was, however, a marked improvement in gain in IQ levels above 65.

6. With the disadvantaged child, a different pattern appeared.

a. The experimental lessons were significantly superior in IQ levels 66-100, but were not as effective as the enriched environment in IQ levels below 65 and above 100.

b. The experimental lessons were significantly superior with the disadvantaged child with a MA of 4 years and above. They were inferior to the enriched curriculum below this MA.

c. The experimental lessons were significantly superior with disadvantaged children with a CA of 5 years or older but were inferior to an enriched environment below that CA.

7. Because the control method (enriched environment) showed very satisfactory gains in conservation below 3 years in contrast to the experimental method, one must reject the hypothesis that there is a biological limit (physical and/or neurological) at approximately MA 3 years, below which conservation could not be taught. One can only assume that the experimental method is not appropriate for use below the MA of 3 years.

8. When the induced conservation was tested after 6 weeks for retention, no extinction had occurred. The subjects post-tested late were significantly higher (.05) in total conservation concepts than subjects post-tested immediately after teaching.

Findings revealed by the study about which no previous hypothesis had been made.

9. When the advantaged child and the disadvantaged child were matched in MA, the advantaged child still made significantly greater gains in this type of learning which is basically logic. The advantaged child's initial pretest score was higher and his gain was greater than the disadvantaged child with the same MA.

10. When the advantaged child and the disadvantaged child were matched as to IQ level, the advantaged child made significantly greater gains in learning (logic).

11. When the advantaged child and the disadvantaged child were matched in CA, at the 5 year level, the advantaged child averaged $2\frac{1}{4}$ years older in MA. (It may be noted then that when the data indicated that the CA of 3 with the advantaged children and the CA of 5 with the disadvantaged children was the appropriate grade placement of this particular curriculum the stage of mental development of the two groups would be approximately the same.)

12. Since all levels showed gain in conservation concepts and because the rate of gain was significantly affected by difference in teaching methods, one may assume that conservation is a learning process and not primarily a biological maturational process for the MA levels $2\frac{1}{2}$ through 9, the limits included in this study.

It appeared that conservation did not suddenly occur at ages 7, 9, or 12 but was acquired gradually, bit by bit, from infancy (2 years or younger) through the years and reached maturity, or the stage of conservation, as soon as sufficient evidence had come to the attention of the subject, which might be at age 3 or 4 (Young, 1967) if the evidence were systematically brought to the attention of the child or at ages 7, 9, or 12, if this were left to chance.

It also appeared that a major factor in the age of the appearance of conservation was dependent on the difficulty of the conservation task. If a series of tasks of graduated difficulty were provided, it was evident that he conserved in the simpler tasks earlier than in the more complicated ones.

13. Because of the pattern of interaction between the experimental method and the control method it seemed that as soon as a language readiness was achieved at about CA 3 for advantaged children and a CA of 5

for this particular group of disadvantaged children, the structured play (experimental method) was superior whenever the learning task was difficult in relation to the maturity of the child. However, when the task was easy by virtue of the child nearing the completion of the concept by incidental observation, the method was not a crucial matter and made no significant difference.

14. The experimental method was significantly superior for teaching rational counting to the disadvantaged children at the MA of 3-5. Since it was not primarily the purpose of the lessons to teach rational counting, it was assumed that the heavy emphasis on use of concrete objects coupled with occasional counting accounts for the effectiveness with this young age group.

Recommendations

The results of the study indicate that these lessons in conservation could profitably be placed in the nursery school and kindergarten of children with a MA of 4 years or above or in the curriculum for 3-year-olds who are well advanced in language development.

With underprivileged children, the correct placement would be in kindergarten or early in first grade.

Because the learning showed a gradual increase, it would seem wisest to repeat the conservation lessons using new materials. It is the opinion of the researcher that this should be done approximately once a year. However, no evidence exists in the present study as to the optimum length of the cycle. This is only a subjective judgment on the part of the researcher after working with approximately 300 preschool children using the described lessons.

Additional research is needed using a 3 or 4 dimensional ANOVA to isolate any possible effect of the teacher factor from social class. Follow-up studies should also be done with first graders who have had conservation training to verify the logical assumption that conservation must precede meaningful work in addition and subtraction and that conservation of number preceding formal number work should make the work in addition and subtraction easier for students.

BIBLIOGRAPHY

1. Bruner, J. S., Oliver, R. R., and Greenfield, M. et al. Studies in Cognitive Growth. New York: John Wiley & Sons, 1966.

2. Lindquist, E. F., Design and Analysis of Experiments in Psychology and Education. Boston: Houston-Mifflin Co., 1956.

3. Mermelstein, E. and Meyer, E. "Number Training Techniques and Their Effects on Different Populations." Unpublished paper presented at the annual meeting of the American Educational Research Association, February, 1968.

4. Pigget, J., "Equilibration and the Development of Logical Structures," Discussions on Child Development, Vol. IV: Organization Study Group on the Psychological Development of the Child (Quotation by Mead) Edited by J. M. Tanner and B. Inhelder. New York: International Universities Press, 1960.

5. Smedslund, J. Apprentissage des Notions de la Conservation et de la Transitivite do Poids. Etudes d'Epistemologie Genetique, 9 (1959), pp. 85-124.

6. _____. "The Acquisition of Conservation of Substance and Weight in Children: I Introduction." Scandinavian Journal of Psychology, 2 (1961), pp. 11-20.

7. _____. "The Acquisition of Conservation of Substance and Weight in Children: II External Reinforcement of Conservation of Weight and of the Operations of Additions and Subtractions," Scandinavian Journal of Psychology, 2 (1961) pp. 71-84.

8. _____. "The Acquisition of Conservation of Substance and Weight in Children: III Extinction of Conservation of Weight Acquired Normally and by Means of Empirical Controls on a Balance," Scandinavian Journal of Psychology, 2 (1961), pp. 85-87.

9. _____. "The Acquisition of Conservation of Substance and Weight in Children: IV Attempt at Extinction of the Visual Components of the Weight Concept," Scandinavian Journal of Psychology, 2 (1961), pp. 153-55.

10. _____. "The Acquisition of Conservation of Substance and Weight in Children: V Practice in Conflict Situations Without External Reinforcement," Scandinavian Journal of Psychology, 2 (1961), pp. 156-60.

11. _____. "The Acquisition of Conservation of Substance and Weight in Children: VI Practice on Continuous vs Discontinuous Material in Problem Situations Without External Reinforcement," Scandinavian Journal of Psychology, 2 (1961), pp. 203-10.

12. _____. "The Acquisition of Conservation of Substance and Weight in Children: VII Conservation of Discontinuous Quantity and Operations of Adding and Taking Away," Scandinavian Journal of Psychology, 3 (1962), pp. 69-77.

13. _____. "Transitivity of Preference Patterns as Seen by Pre-School Children," Scandinavian Journal of Psychology, 1 (1960) pp. 49-54.

14. Wallach, L., and Spratt, R. "Inducing Number Conservation in Children," Child Development, 35 (September-December, 1964).

15. Wohlwill, J., "un Essai d'Apprentissage Dans le Domonie de la Conservation du Numbre," Etudes d'Epistemologie Genetique, 9 (1959).

16. Young, B. "Inducing Conservation of Number, Weight, Area, Mass and Volume in 3 and 4-Year Old Pre-school Children," Unpublished paper presented at annual meeting of the American Educational Research Association, February, 1968.

APPENDICES

APPENDIX A

TEST FOR ROTE COUNTING*

Procedure - The subject was seated near the examiner at a small table. He was then asked, "Can you count? Count with me. One, two, --." After the subject began counting with the examiner, the examiner hesitated before each number allowing the subject to speak first. The number just preceding the one on which the subject faltered was recorded as his score.

Materials - None.

TEST FOR RATIONAL COUNTING

Procedure - The subject was asked to lay a specified number of objects on the table between himself and the examiner.

Form I

Materials - Checkers

Test Item - 2a. "Put 3 of these on the table.
Put 5 of these checkers on the table.
Put 10 of them on the table.
Now put 15.
Can you put 20?"

Form II

Materials - Crayons

Test Item - 2 b. Identical wording as used in Form I

*Subject to copyright.

TEST FOR DISCRIMINATION OF NUMBER

Procedure - If the subject was very young, retarded, or seriously handicapped in speech, the starred items were offered entirely without speech, and the child kept the candy he chose. In all other cases the candies were placed on the table in two groups as designated by the item and the subject did not keep the candy.

Form I

Materials - Small assorted gumdrops

Test Item -	*6a.	"Which is more?"	3 (grouped closely) 2 (widely spaced)
	7a.	"Which is more?"	3 (widely spaced) 5 (grouped closely)
	8a.	"Which is more?"	3 (widely spaced) 4 (grouped closely)
	9a.	"Which is more?"	5 (grouped closely) 4 (widely spaced)
	10a.	"Which is more?"	5 (widely spaced) 6 (grouped closely)

Form II

Materials - M & M candies, assorted colors

Test Item - *6b. Item worded and spaced exactly as 6a.

7b. Item worded and spaced exactly as 7a.

8b. Item worded and spaced exactly as 8a.

9b. Item worded and spaced exactly as 9a.

10b. Item worded and spaced exactly as 10a.

TEST FOR CONSERVATION OF CARDINAL NUMBER
(PROVOKED CORRESPONDENCE)

Procedure - In each item the examiner first placed the objects into a one-to-one correspondence, and then rearranged them.

Form I

Materials - Six doll plates and six toy spoons

Test Item - 11. Examiner put a spoon on each plate, then collected them into a short row as opposed to the longer row of plates. "Is there the same number of plates as spoons or is there more of one than the other? If so, which?"

12. The plates were stacked and the spoons fanned out into a longer row. "Is there the same number of plates as spoons or is there more of one than the other?"

13. Using six cards and six checkers put a red checker on each card and then group checkers--"Is there a red checker for every card or is there more of one than the other."

14. Using 12 cards and 12 red checkers, put one checker on each card and then stack both. "Is there a checker for each card or is there more of one than the other?"

15. "Put a penny in your pile each time I put one in mine." Rearrange piles. "Do we have the same amount or does one of us have more than the other?"

Form II

Materials - Six toy auto transport trucks and 12 cars

Test Item - 16. A little blue car was placed directly behind each truck trailer. Then the line of cars was compressed. "Is there the same number of cars as trucks or is there more of one than the other?"

17. The line of trucks was then compressed and the cars put out on the "highway" and spaced out. "Is there the same number of cars as trucks or is there more of one than the other?"

18. Using 6 crayons and 6 erasers put a crayon beside each eraser and then stack erasers. "Is there an eraser for every crayon or are there more crayons?"

19. Using 12 crayons and 12 erasers, put crayons beside erasers and then group crayons. "Are there as many crayons as erasers or are there more erasers?"
20. Using 20 roasted peanuts in the shell, say "Put a peanut in your pile each time I put one in mine." Rearrange piles. "Do we have the same amount or does one have more than the other?"

TEST FOR ADDITIVE COMPOSITION OF NUMBER

Procedure - The examiner was equipped with a box of small candies from which were taken the prescribed number and color of candies. These were then arranged on the table in view of the subject before the question was asked.

Form I

Materials - Six small red gumdrops and six small orange gumdrops. Several other small gumdrops of assorted colors.

Test Item - 51. "If you got one red gumdrop in the morning and one red gumdrop in the afternoon." (Examiner demonstrated with gumdrops on the table as he spoke.) "The second day you got two orange gumdrops in the morning but none in the afternoon. Did you get the same number of red gumdrops and orange gumdrops? Or, did you get more one day than the other?"

52. Same procedure as above using the sets two and one vs. three and zero.

53a. Same procedure using numbers two and four vs. five and one.

53b. Same procedure using numbers four and eight vs six and six.

54. Examiner placed a pile of 12 assorted colors of gumdrops in center of table between subject and examiner. "Give you and me the same amount. The colors don't matter."

55. Place a pile of four assorted colors of gumdrops in front of the subject and eight assorted colors in front of the examiner. "I didn't get those divided very well. Will you fix it so we each have the same amount? All must be used and no more taken or put back in the box."

Form II

Materials - Six green M & M's and six yellow ones and 14 of assorted colors.

Test Item - 56. Same procedure as No. 51 using sets two and one vs one and two.

57. Same procedure as No. 52 using sets two and two vs three and one.

58a. Same as No. 53a using sets three and three vs. five and one.
58b. Same as No. 53b using sets five and nine vs. seven and seven.
59. Same as No. 54 using 14 gumdrops.
60. Same as No. 55 using groups of nine and five.

TEST FOR DISCRIMINATION OF LENGTH

Procedure - The examiner scattered a set of graduated wooden blocks on the table.

Form I

Materials - A set of nine graduated 2" wooden cylinders. The shortest cylinder was 2" tall with ½" increments in each succeeding cylinder.

Test Item - 21. Used two cylinders of widely different size. "Which is smaller?"
22. Used 9 seriated cylinders laid in order. "Now can you find the smallest?"
23. "Can you find the largest?"
24. Scramble cylinders, make the smallest protrude at one end past a longer cylinder and the longest cylinder indented at one end against a shorter cylinder. "Now can you find the smallest?"
25. "Can you find the largest?"

Form II

Materials - A set of nine graduated 2 x 2 wooden blocks. The shortest block was 2" tall with ½" increments in each succeeding block.

Test Item - 26. Procedure the same as No. 21. "Which block is bigger?"
27. Procedure the same as No. 22. "Which is biggest?"
28. Procedure the same as No. 23. "Now can you find the smallest?"
29. Procedure the same as No. 24. "Now can you find the smallest?"
30. Procedure the same as No. 25. "Can you find the largest?"

TEST FOR SERIATION

Procedure - The examiner built a stairway using 9 blocks and then removed it. The subject was asked to build one just like the one the examiner had made. The last item required interpolating 5 more blocks from a second set.

Form I

Materials - Two sets of nine graduated 2" wooden cylinders. Smallest cylinder 2" long with $\frac{1}{2}$" increments. Second set of cylinders smallest cylinder $2\frac{1}{4}$" long with $\frac{1}{2}$" increments.

Test Item - 31. "Make a stairway." (A pass required three seriated correctly.)
32. A pass required five seriated correctly.
33. A pass required seven seriated correctly.
34. A pass required nine seriated correctly.
35. With nine standing seriated correctly, the examiner took 5 cylinders from the second set of cylinders and said, "Put these into the stairs where they fit."

Form II

Materials - Two sets of nine graduated 2 x 2 wooden blocks. Smallest block of the first set was 2" long with gradations of $\frac{1}{2}$" in the ucceeding blocks. Smallest block of the second set was $2\frac{1}{4}$" long with gradations of $\frac{1}{2}$" in the succeeding blocks.

Test Item - 36. Same as No. 31.
37. Same as No. 32.
38. Same as No. 33.
39. Same as No. 34.
40. Same as No. 35

TEST FOR CONSERVATION OF ORDINAL NUMBER

Procedure - The series of questions began with a 9 step stair between the subject and the examiner. Each item describes its own procedure.

Form I

Materials - Two sets of nine graduated 2" wooden cylinders. Smallest cylinder 2" long with $\frac{1}{2}$" increments. Second set of cylinders smallest cylinder $2\frac{1}{4}$" long with $\frac{1}{2}$" increments. One inch wooden doll.

Test Item - 41. In the completed 9-step stairs, "Count the steps. How many are there?"

42. "This little boy has walked up this far. Counting the step he is standing on, how many steps has he stepped on?"

43. "If he wants to go on to the top, how many more steps must he step on?"

44. Examiner arranged steps randomly. "Now these are big rocks and boulders which he is climbing on. If he is up this high and has climbed on every one that is smaller than this one, how many has he climbed on to get here counting the one he is standing on?"

45. "If he must climb on every one that is larger than this one to get to the top, how many must he still climb on to get to the top?"

Form II

Materials - Two sets of nine graduated 2 x 2 wooden blocks. Smallest block of the first set was 2" long with gradations of $\frac{1}{2}$" in the succeeding blocks. Smallest block of the second set was $2\frac{1}{4}$" long with gradations of $\frac{1}{2}$" in the succeeding blocks. A 1" wooden doll.

Test Item - 46. Same as No. 41.
47. Same as No. 42.
48. Same as No. 43.
49. Same as No. 44.
50. Same as No. 45.

TEST FOR MULTIPLICATIVE COMPOSITION OF NUMBER

Procedure - The general procedure was to illustrate one-to-one correspondence with two sets of objects. The procedure was then repeated with additional objects. Each item describes its specific procedure.

Form I

Materials - Six doll plates, six toy spoons, six toy forks, five file cards, and 20 checkers.

Test Item - 62. Six plates were placed in a row on a table between subject and examiner. A spoon was placed on each plate then immediately picked up and laid in a pile. A fork was then placed on each plate and immediately removed and placed with the spoons. "If we put all the silverware back on the plates, how many pieces would be on each plate?"

66. Five white file cards were laid out in a row and a red checker placed on each one. The checkers were immediately removed and placed in a small row in front of the file cards. The same procedure was followed with five black checkers which were then immediately stacked. "If all the checkers were laid back on the cards, how many would be on each card?"

67. Procedure repeated with five more red checkers which were then stacked beside the first group. "If all the checkers were laid back on the cards, how many would be on each card?"

68. Procedure repeated with five more black checkers which were then stacked beside the other two stacks. "If all the checkers were laid back on the cards, how many would be on each card?"

Form II

Materials - Six toy auto transport trucks, six blue cars, six orange cars, six pencil erasers, 24 crayons.

Test Item - 70. Six trucks were lined up facing the subject. A blue car was placed behind each truck. They were then "driven out on the highway" and an orange car placed behind each truck. The orange and blue cars were then put together. "If all the cars were loaded up on the trucks

to be hauled away, how many cars would be on each truck?"

71. Six erasers were lined up on the table. A crayon was placed by each one then removed. Another crayon was placed by each eraser and then added to the first row of crayons. "If all the crayons were put back beside the erasers, how many crayons would be beside each eraser?"
72. The procedure was repeated with six more crayons. "If all the crayons were put back beside the erasers, how many crayons would be beside each eraser?"
73. The procedure was repeated with six more crayons. "If all the crayons were put back beside the erasers, how many crayons would be beside each eraser?"

TEST FOR TRANSITIVITY

Procedure - The procedures are identical with those used for multiplicative composition except the group which has been removed is hidden from complete view of the subject by the examiner's hand to prevent perceptual clues biasing the answer. Then, of course, the question put to the subject is different than in multiplicative composition. The procedures for each item are necessarily detailed therein.

Form I

Materials - Six doll plates, six toy spoons, six toy forks, six toy knives, five white file cards, five red checkers, and five black checkers.

Test Item - 61. Six plates placed in a row on table between subject and examiner. A spoon is placed on each plate then immediately picked up and laid in a pile. A fork is then placed on each plate and immediately removed and held in the hands of the examiner out of sight of the subject. Are there as many spoons as forks? Or, are there more of one than the other?

63. Procedure repeated with the toy knives. Are there as many knives as spoons? Or, are there more of one than the other?

65. Five white file cards are laid out in a row and a red checker placed on each one. The checkers are immediately removed and placed in a small row in front of the file cards. The same procedure is followed with five black checkers which are then immediately stacked with the examiner's hand remaining over the stack to prevent visual observation. Are there as many black checkers as red checkers? Or, are there more of one than the other?

Form II

Materials - Six toy auto transport trucks, six blue toy cars, six orange toy cars, six erasers and 12 crayons.

Test Item - 69. Six trucks are lined up facing subject. A blue car is placed behind each truck ready to be loaded up. The blue cars are then "drive out on the highway" (placed in a long line directly behind each other) and an orange car is placed behind each truck. All cars are

then grouped together, intermixed to prevent counting or visual comparison. Are there as many blue cars as orange cars or are there more of one than the other?

98. Three erasers are spread out on table between subject and examiner. A red crayon is placed beside each eraser. These are immediately removed and laid unobtrusively to the side and a green crayon is then placed by each eraser. These, too, are removed and held in the hand of examiner. Are there as many red crayons as green crayons or are there more of one than the other?

99. Six crayons are then laid in a row on the table and are paired with six erasers which are immediately removed and stacked to be replaced by six more erasers which are also removed and placed under the hand of examiner to the opposite side of the table. Are there as many erasers on this side of the table as there are on that side of the table? Or, are there more on one side than on the other?

TEST FOR CONSERVATION OF WEIGHT

Procedure - Examiner stated that the two balls weighed the same, the subject was asked to pick up both balls in his hands so he might be sure. If there was any doubt the plasticene was adjusted until the subject stated that one was just as heavy as the other.

Form I

Materials - Two $\frac{1}{4}$ pound balls of plasticene.

Test Item - 75. One ball was reformed into a football. "Do they still weigh the same or is one heavier than the other?"

77. The football was then transformed into a weiner. "Do they still weigh the same or is one heavier than the other?"

79. Weiner was reverted into a round ball and equivalence again established. One ball was then sliced in halves with a knife. "Does this ball weigh the same as the two halves put together? Does the clay on one side weigh more than the clay on the other side?"

Form II

Materials - Same two balls of plasticene as in Form I.

Test Item - 81. Procedure was the same as in No. 75 except instead of football a hamburger was formed. Same questions as in No. 75.

83. Now the hamburger was transformed into a pancake. Same question as No. 77.

85. Now pancake was reverted into ball and cut into quarters. Same as No. 79.

TEST FOR CONSERVATION OF MASS

Procedure - Examiner stated that two balls contained the same amount of clay, that one ball had just as much clay as the other. Subject agreed or adjusted clay until agreement was reached.

Form I

Materials - Two $\frac{1}{4}$ pound plasticene balls.

Test Item - 74. One ball was reformed into a football. "Do they still have the same amount of clay or does one have more than the other?"

76. The football was then transformed into a weiner. "Do they still have the same amount of clay or does one have more than the other?"

78. Weiner was then converted into a round ball and equivalence established. One ball was then sliced into halves with a knife. "Do they will have the same amount of clay--this ball and the two halves added together?"

Form II

Materials - Same as above.

Test Item - 80. Same procedure as No. 74 except instead of a football a hamburger was formed. Same question as No. 74.

82. Now the hamburger was transformed into a panacke. Same question as No. 76.

84. Now pancake was reverted into a ball and cut into quarters. Question the same as No. 78.

TEST FOR CONSERVATION OF VOLUME

Procedure - The series of manipulations began with two 9-ounce glasses filled equally with water.

Form I

Materials - Two identical 9-ounce glasses, six 3-ounce glasses identical to the 9-ounce glasses except for size, one tall slim olive jar, one short wide peanut butter jar, a pitcher of water.

Text Item - 86. Examiner poured one 9-ounce glass of water into two of the smaller glasses. "Is there still the same amount of water in these two smaller glasses added together as there is in the one larger glass, or is there more on one side than the other?"

89. The examiner poured two small glasses of water back into the large glass and reaffirmed equivalence. He then poured the water from one large glass into six smaller glasses. "Is there still the same amount of water in these six smaller glasses all added together as there is in the one larger glass, or is there more on one side than the other?"

90. The examiner filled two 3-ounce glasses equally and established equivalence. He then poured water from one into the tall, slim container. "Is there still the same amount of water in this bottle and this glass or is there more in one than the other?"

*91b. Same as No. 90 except contents of one glass were poured into tall, slim container and contents of other glass were poured into short wide container, the two extremes in bottles were compared.

*102. The two 9-ounce glasses were each filled half full. Then two identical $\frac{1}{4}$ pound balls of clay were introduced. "See the water in both glasses comes up to here. If I drop this ball into this glass the water comes up this high. If I make this other ball into a football and

---

*Items 91b and 102 were needed only at post-test and were used in both forms of the test.

and drop it into the other glass, will the water in that glass be as high as this, higher or lower?"

*103. The tall slim bottle and the short wide jar were filled to the same depth with water. Two identical small (1 inch in diameter) balls of clay were introduced. "If I put a ball of clay into the water in the wide jar, the water comes up this much. If I make the other ball into a weiner and put it into the slim jar, will the water come up the same amount, more, or not so much?"

Form II

Materials - Same as above.

Test Item - 87. Same as No. 86 except three glasses were used instead of two.

87. Same as No. 89 except five glasses were used instead of six.

91a. Same as No. 90 except contents of one glass were poured into a short wide container.

*91b. Same as Form I.

*102. Same as Form I.

*103. Same as Form I.

---

*Items 91b, 102, and 103 were needed only at post-test and were used in both forms of the test.

TEST FOR CONSERVATION OF AREA

Procedure - A card was presented to the subject for his inspection. The same question was asked in each item of both Form I and Form II, "Is there the same amount of paper in this shape as that one or is one more than the other?"

Form I

Materials - Three red 8x11 cards with two forms on each card. Forms were made of various arrangements of 1" squares of white paper or diagonals of the same with the 1" square marks obvious. See Appendix I for reproductions of the card items.

Test Item - 93. Card 2 (scored for Form I only)
92. Card 1 - same question.
94. Card 3 - same question.
96. Card 5 - same question.

Form II

Materials - Same as above. See Appendix I for reproductions of card items.

Test Item - 93. Card 2
92. Card 1 (scored for Form II only)
95. Card 4
96. Card 6

TEST FOR REVERSIBILITY

Procedure - Items 86b and 87b began with 3-ounce glasses of water, one 9-ounce glass of water and 1 empty 9-ounce glass. The balance of the items deal with one $\frac{1}{4}$ pound ball of clay and another $\frac{1}{4}$ pound piece of clay which has been formed into the shape designated in the item.

Form I

Materials - Two balls of clay, two 9-ounce glasses, six 3-ounce glasses, a pitcher filled with water.

Test Item - 86b. "If I would pour the water from <u>both</u> of these little glasses back into the big glass, would it have as much water as the other big glass?"

101. "If I made this weiner back into a ball, would it have the same amount of clay as that one?"

77b. "If I made this weiner back into a ball, would the balls weigh just the same or would one ball be heavier than the other?"

Form II

Materials - Identical to those in Form I.

Test Item - 87b. "If I would pour the water from all <u>three</u> of these little glasses back into the big glass would it have as much water as the other big glass?"

100. "If I made this pancake back into a ball, would it have as much clay as that one?"

83b. "If I made this pancake back into a ball, would it weigh just the same as that ball or would one ball be heavier than the other?"

APPENDIX B

LESSON 1*

Topic - Conservation of number

Materials - Doll plates, wrapped candies, and a small bowl.

Beginning procedure - A small plate was distributed to each child. Then a little bowl was placed in the center of the table and each child was given a wrapped candy and asked to lay it on his plate.

"Do we each have a plate?
Do we each have a candy? Now, everyone put his candy into the bowl. (c)
Were there as many pieces of candy as there were plates?(a, b)
Were there as many plates as there were candies?(a, b)
Were there the same number of plates as there were children? (a, b) Now, take the candy back out so that we can be sure. (a, c, g) Put it back on your plate. Now, hold the candy in your hand and put your plate in the middle of the table. (c) Just lay the candy on the table in front of you. (c)

Are there the same number of candies as plates? (h) Are there as many? (h) Now put your candies in a tiny pile in the middle of the plates. (c)

Are there the same number of plates as candies?(h) Take your plates back and put your candy back on them. (a, c)

Are there the same number of candies and plates? (g) Stack up the plates and put the candy in a row. (c)

Are there the same number of candies as plates? (with eyes closed) (b, h) Put your candy into the bowl again. (c) Now I will take one piece of candy out and put it back into the sack. (d)

Will there be a piece of candy for every plate now? (b)
Why not? (f) Each person put his candy back on his plate. (c, g)
Are there the same number of candies as plates? (h)
What should be done? (a) Examiner does as children suggest and puts one back (c, g)
Now are there the same amount? (h)
Why wasn't there enough for everyone? (d, f)

Put your plates in a line down the center of the table and your candies in a short line beside them. (h, c)

Are there the same number of candies as plates? (h) It looks as though there are more plates. I will take away enough plates to make the rows look the same. (d, c)

Now are there the same number of plates as candies? (h, b) Put the candies and plates back in front of you to be sure. (a, c, g)
Are there the same number? (j, h)
What should we do? (f, d)

*Subject to copyright.

Why weren't there enough plates? (f) Stack your plates in the center of the table and lay the candy around the stack. (c) There doesn't appear to be enough plates for that many pieces of candy. I'll add 2 more. (d)

Will there be the same number of plates as candies?

Why not?" (f) Replace plates and candies. (c, d)

"Are there the same number of plates as candies now? (h, g)

Why not? (f) Put extras back into sack. Put your candies in a small circle. Now put your plates around the candy. (c) Take a good look at the plates and candies. Are there the same number of plates and candies? (h) Now each person take a piece of candy and put it on your plate to be sure they are the same and then eat the candy." (a, c, g)

LESSON 2

Topic - Conservation of number

Materials - Doll spoon and fork and a box of plastic spoons.

Beginning procedure - Part I, a box of plastic spoons was set in the middle of the table. Part II, each child was given a doll spoon and fork.

Part I

"Can you count out 3 spoons? 5? 8?" etc. Each child counted some number between 1 and 10 which was within his capacity and listening to others of the group who could count farther or to ten. No errors were allowed. If the child began to falter the examiner came to his aid. When each had a turn or two (approximately 2 minutes), the box of spoons was put away and a doll fork and spoon handed to each child.

Part II

"Do we each have a spoon?
Do we each have a fork?
Do we have the same number of spoons as forks? (j)
Do we have as many forks as children? (j) Put them in a long row. Now put your spoons in a short row.

Are there the same number of spoons as forks or are there more of one than the other? (c, h) Put your spoon and fork back together to see whether they are both still there. (a, c, g) Now stack your spoons up in a stack and lay the forks in a row. (c)

Are there the same number or are there more of one than the other? (c, h) Lay the spoons and forks in a row again and then I'll take away one spoon. (g, c, d)

Are there the same number of spoons and forks or are there more of one than the other (b, h) Put them together again. (a, c) What shall I do?" (f) The examiner replaced the spoon, laid the spoons and forks in a fan shape and asked one child to remove one fork. (c, d)

"Are there the same number of spoons and forks or are there more of one than the other? (h) Why? (f) What should we do?" The child replaced the fork. (c, a) Each was placed side by side and then given to the examiner to put away. (g) The procedure was repeated with the cup and saucer and with one addition and one subtraction. (c, d, h, f, g)

Then the cup was returned and each child received one wrapped candy to place on his saucer. (c)

"Now put your candy in the center of the table." (c) The examiner then gave the child another candy which is also placed in the center of the table. (c)

"If you took all your candy back, how many pieces would you have? (b)

How do you know?" (f) The examiner tried to get the answer, 'Because that was how many I put there.' If this was not forthcoming the examiner asked if it is because that was how many they put there. Then the examiner gave each child another piece of candy which was also put in the center of the table. (c)

"If you took back all your candy now, how many pieces would you have? (b) Why?" (f) Now the examiner gave the children each one more piece of candy. (c)

"Don't do it, but if you put that piece in the middle, too, how many pieces of candy would you have there? (b) How do you know? (f) Just eat that last piece."

LESSON 3

Topic - Conservation of cardinal number (provoked and unprovoked correspondence), multiplicative operations, and rational counting.

Materials - Toy cup and saucer, pencil and card, pair of doll shoes and stockings for each subject; one sack of wrapped candies and a tennis ball.

Beginning procedures - Part I, the lesson began by counting in unison the number of times the examiner bounced a tennis ball on the table. In Part II, each child was equipped with a pair of doll shoes and socks. After these were handed back each received 2 pencils and 2 paper file cards. There were subsequently handed back and each received a doll cup and saucer and a piece of wrapped candy.

Part I

"See if you can count how many times I bounce this ball." The children counted in unison numbers between 3 and 7.

"Now let's see if we can do it all alone." Each had a chance to count alone to a specified number.

Part II

Each child was equipped with a pair of doll shoes and socks.

"Does everyone have as many socks as he has shoes? (h, g)
Put the shoes in a row in the center of the table end to end. (c)
Now put the socks in a row in the center of the table end to end." (c) As the socks were longer they made a longer row.

"Are there the same number of shoes as socks? (h) How do you know? (f) Everyone take back his shoes and socks and let's be sure. (a, c, g) Now put the shoes in a pile in the center of the table and put the socks in a ring around them. (c)

Are there the same number of shoes as socks? (h) How do you know? (f) How can we be sure? (f, g) Hand the shoes and socks back."

Now the examiner hands out two pencils and two file cards to each child.

"Do you have the same number of pencils and papers? (h, g) Put the paper cards in a stack in the center of the table. (c) Now will someone let me have one of their pencils? (d, c)

Are there the same number of pencils now as there are cards? (h)

How do you know? (f) Let's put them all back together to be sure. (a, c, g)

Were you right? (g) What shall I do?" (f) The pencil was returned and procedure was repeated with pencils and cards laid in a line in the center of the table. "That is such a long line I believe I should add about two more file cards to make it the same as the pencils. (b, d)

Are there the same number of pencils and file cards? (h)

Why not? (f) What should I do?" (f) Examiner removed the extra cards. (g)

"Is it the same now? (g) Let's check to be sure. (a, g, c) Hand the pencils and cards back."

The examiner handed each a cup and saucer. The procedure was repeated with the cup and saucer with one addition and one subtraction. (c, d) Then the cup was returned and each child received one wrapped candy to place on his saucer.

"Now put your candy in the center of the table." The examiner then gave each child another candy which was also placed in the center of the table.

"If you took all your candy back, how many pieces would you have? (b, h)

How do you know?" (i, a, f) The examiner tried to get the answer, 'Because that was how many I put there.' (f) If this was not forthcoming the examiner asked if it was because that was how many they put there. (g, h) Then the examiner gave each child another piece of candy which was also put in the center of the table.

"If you took back all your candy now, how many pieces would you have? Why?" (a, i, f, h) Now the examiner gave each of the children one more piece of candy.

"Don't do it, but <u>if</u> you put that piece in the middle, too, how many pieces of candy would you have there? (b, a, i) How do you know? (f) Just eat that last piece."

LESSON 4

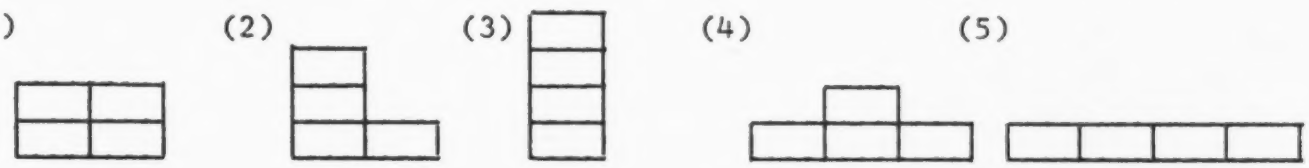
Topic - Conservation of area, mass, and volume

Materials - Unmarked dominoes (upside down dominoes), squares of milk chocolate bars.

Variables

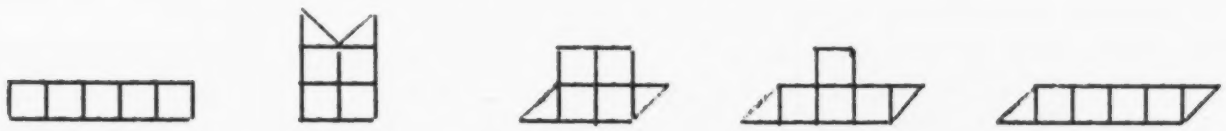
Each subject was asked to count out four dominoes from bag and then arrange them in the following patterns in duplication of the pattern made by the examiner.

(1) (2) (3) (4) (5)



After each arrangement, the subjects were asked, "Do you still have four dominoes?" (h, c) If they were not sure, they were asked, "Have any been taken away? (d, f) Have any been added? (d, f) Then, are there still the same number? (f) Count to be sure?" (g) Then each child was asked to count out five chocolate squares. Each child had one square cut through diagonally with a knife. As this was done, each child was asked, "Am I giving you more candy? (f) Am I taking any away with me? (f) Do you still have the same candy you did have?" (i) The pieces of chocolate were then placed in the following arrangements.

(1) (2) (3) (4) (5)



After each arrangement, the question was asked, "Do you still have the same amount of candy? (i) Do you still have the same number of pieces? (h) How could you count it to make sure?" (f) The answer was to put the two halves or pieces together to make a whole piece and then count. "Now you may eat it."

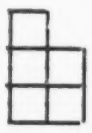
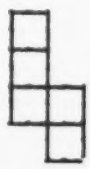
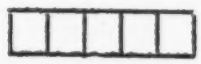
LESSON 5

Topic - Conservation of area, mass, and volume

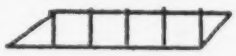
Materials - A box of 1" squares of white cardboard and a sack of softly blown and tied balloons.

Beginning procedure - Part I is a duplication of lesson 4 using a material with less depth. Procedures and questions identical.

The subjects were asked to count out five squares of cardboard. These were then arranged in the following patterns in duplication of the pattern made by the examiner.

(1)  (2)  (3) 

After each reformation, the subjects were asked questions the same as in lesson 4. They were urged to think whether any had been taken away, (f, d) any added, (f, d) and then to recount as a further check. (g) Then the examiner cut one square in two, (c) each time the question and procedure were identical with lesson 4. It was then arranged

(1) (2) 

and the subjects questioned. (f, d) Then the paper was collected and the examiner demonstrated with a softly blown and tied balloon. "What is inside? Can it get out if I don't break or untie the balloon? If I squeeze the balloon here, where does the air go?" (Up and down.) (j, c, e) "The balloon gets tall and skinny. (j, c, e) If I squeeze it this way where does the air go?" (Sideways.) (j, c, e) "The baloon gets, short and fat. (j, c, e) Is it the same air? (i) Is there any more or less? (d, i, h) Did I put any more in? (d) Did I take any out? (d) Then it must be the same amount." (i, f, g)

Then softly blown, tied balloons were distributed to each child. "Let's see if your's acts the same as mine? (c) Can the air get out? (i) Now squeeze it this way . Where did the air go? (Up and down) (j, e) What shape did the balloon get (tall and skinny)? (j, e) Now squeeze it this way . Where did the air go? (Sideways) j, e) What shape did the balloon get? (Short and fat) (j, e) Did you put in any more air? (d) Did you let any air out? (d) Is it still the same

air? (i, h) When it is short, it is (fat). (j, f, e) When it is tall it is (skinny). (j, f, e)

LESSON 6

Topic - Conservation of weight and mass, rational counting, discrimination of length and seriation

Materials - One balloon, two balls of plasticene clay, teeter totter made from a foot long wooden ruler, and an 8-ounce juice can, tennis ball, box of plastic straws, set of nested wooden blocks (5).

Beginning procedure - This lesson except for counting out straws and seriating the wooden blocks was entirely a demonstration lesson. Pupil participation was limited to verbal replies to rather continuous questions asked by the examiner as the demonstration proceeded. This method of presentation seemed to in no way lessen interest as interest was high and answers immediately forthcoming from the subjects. Part I deals with conservation of weight and mass. Part II, rational counting. Part III, discrimination of length and seriation.

Part I

"Remember the balloon? When we squeezed the side it got taller." (j) The examiner demonstrated with a balloon coincident with his comments. (c) "When we squeeze it down, it got fatter but the air stayed just the same." (j, i) The experimenter then worked in the center of the table with clay. "Now, let's see if it works the same with clay?" (c) The examiner demonstrated with a soft ball of clay. "Where did it get smaller? (e) Did it get longer? (e) Is it more clay? (i) Now, I'll make it back into a ball and squeeze down the top." (a, c, e)

"Did it get fatter?" (j, e) The examiner then made it back into a ball. (a, c) "Now, I'll make a cup out of it. (h, c) Is it still the same piece of clay? (i) Where did it get larger. (e, j) Where did it get smaller?" (e, j) The examiner took a piece off and put it on the top. (a, c) "Is it still the same amount of clay?" (h) The examiner took a piece off the bottom and put it on the sides. (a, c) "Is it still the same amount?" (h)

"Who has teetered on a teeter totter? If one person is heavier than the other, what happens? If two people get on one end and one on the other, what happens?" (f) The demonstrator then made miniature teeter totter from foot ruler and small can and demonstrated how it tipped up and down. "See the side that is heavier goes down." (f) Demonstrated. (g) He then repeated the demonstration with weight (g) "These balls are the same. See they exactly balance. (j) Now I'll put a piece of one back into the sack. (c, d) Now are they the same? (h, g) Now I'll add a piece. (c, d, g) Are they the same? (h) Now,' I'll take it back off and put the clay away." (c, d, g)

Part II

"I'll bounce this tennis ball and let's count together."

Part III

Each child was asked to count out 3 - 10 straws.

Part IV

"Put these spoons in order with the smallest here and the largest there. (j, h, g)

Who can make a stairs out of these boxes?" (h, g)

LESSON 7

Topic - Conservation of volume, seriation with interpolation and rational counting.

Materials - Nest of 13 plastic cups, a small red rubber ball, several pitchers of grape juice, 6-ounce paper cups, 3-ounce paper cups, 4" paper sauce dishes, a box of graham crackers.

Beginning procedure - The lesson began with a review of rational counting and seriation.

The examiner bounded the ball and the children counted in unison and then individually the number of bounces (3-10). Then each child tried to make a stairs of the 13 cups, starting with the largest, and each time choosing the largest of the remaining cups. First, each child seriated the set of 13 cups from which one cup had been removed and given to next child. After cups were seriated, the next child placed extra cup into proper order in the series. (h) (Different cup each time.) Then the examiner demonstrated with a 6-ounce cup and two 3-ounce cups and a saucer. He filled the 6-ounce cup, then after putting the pitcher away, poured the contents of the 6-ounce cup into the two small cups saying, "Did I put any back into the pitcher? (d) Did I take any more out of the pitcher? (d) Is it still the same juice? (i) Is it still the same amount of juice? (i) Why?" (f) (Examiner tried to get the answer of addition/subtraction or identity.) "I'll put it back to check. (a, g) I just divided it in two pieces like we did with the chocolate squares and the pieces of paper. Now I'll pour it into the flat, wide sauce dishes. (c) Did I take any out? (d) Put any extra in? (d) Is there the same amount here as there is over here? (h, i) It looks taller in this cup. (j, e) In what way is it smaller? (j, e) If it gets wider this way, (e, j) where must it get smaller? (e, j) Did the balloon act that way? (g, e) Did the clay act that way?"

"Now let's see if it works that way for you." The examiner gave each child a 6-ounce paper cup, two, three or four 3-ounce cups or a 4" saucer. He filled each 6-ounce cup until all agreed that they were filled equally. Then he asked each child to pour his juice into his other container or containers. (c) "Did I give any one more juice? (d) Did I take juice away from anyone? (d) Does everyone still have the same juice he had? (i, f) Is it the same amount of juice you had before? (h) Does (subject No. 1) have the same amount as subject No. 2? (g, h) Does subject No. 3 have the same as No. 1, No. 4, and No. 3 (g, h) Let's pour it back into the first cup to be absolutely sure." (c, a, g) The demonstrator then passed out squares of graham crackers and asked the children to break theirs in two or three or four pieces. (c) "Does everyone still have the same amount of crackers and juice? (h, i) Put the pieces back together to be sure. (a, c, g) Now if you all have the same of everything, go ahead and eat it." (g, c)

LESSON 8

Topic - Multiplication, seriation, additive composition

Materials - Three types of small candies, 13 plastic cups

Beginning procedure - The lesson on seriation of cups was repeated exactly as in lesson 7. The lesson on multiplicity process was repeated exactly as it was in lesson 4.

Then each child was asked to put these materials away and count out five of each, of two kinds of small candies. Then they arrange in duplication of the teacher's design the candies in the following patterns:

3	2	4	1	3	1
2	3	1	4	2	4

After each arrangement each was asked, "Do you still have five of each kind?" (c, h) They were each urged to rearrange them in one-to-one correspondence and then to count for a further check. (c, g)

These materials were then put away and each child was given a random sized group of each of the candies, each group ranging in number from 5-12. The question was then asked, "Do you have the same amount of each or do you have more of one kind than the other kind?" (h) Each was urged to place the candies in one-to-one correspondence, (c, g) and then to count if they could for a double check. (g) After they were sure they had equal amounts of both kinds of candy, they chose the kind they preferred and ate it or else divided each kind in two equal parts and ate half of each kind. (c, g)